THURSDAY, JANUARY 7, 1892.

## INDIAN METEOROLOGY.

*Report on the Meteorology of India in* 1889. By John Eliot, M.A., Meteorological Reporter to the Government of India. Fifteenth Year. (Calcutta: Government Press, 1891.)

*Reports on the Administration of the Meteorological Department of the Government of India*, 1885–1891. (Calcutta, Government Press.)

MR. ELIOT'S Report on the meteorology of India in 1889 is much more than a mere mass of statistics, the raw material for future utilization—more than a retrospective summary of the weather phases and incidents of the year, which may or may not be turned to future account by someone gifted with that scientific imagination that alone can infuse life and meaning into the dry bones of our voluminous weather records. These, indeed, it gives with the usual fulness—not in the fragmentary fashion of a gallery of cabinet studies, but with something of the continuity and breadth of a diorama; and over and above these, it deals with many topics of general interest, which are real and valuable contributions to the body of the science, and on which the remarkably favourable conditions of India—a great tropical country dotted over with a well-organized system of observatories under the direction of a competent physicist—are peculiarly fitted to throw light.

Foremost among these, stands the question of the incident solar heat, which is at once the most important, and at the same time one of which we have the least exact knowledge. To this question more attention has been given by the Meteorological Department of India than by that of any other country; and if we must regretfully admit that the results bear but a small proportion to the labour expended on obtaining them, the experience gained of the difficulties attending the inquiry is not without its value.

Some years ago it was thought that the position of Leh, in the dry climate of Western Tibet, 11,500 feet above the sea, offered peculiar facilities for obtaining trustworthy measurements of the solar heat; and in 1882, Sergeant Rowland, a highly intelligent officer of the Royal Engineers, was selected in England, and after a year's careful training at Roorkee in the use of Balfour Stewart's actinometer, under the personal superintendence of Mr. J. B. N. Hennessey, was despatched to Leh, together with a European assistant, who had been equally trained to the work. They were furnished with elaborate instructions, drawn up by Mr. Hennessey, which contemplated observations of two classes. On all clear days observations were to be taken at noon, and also once in the morning and once in the afternoon, with the sun at certain definite altitudes; and on certain selected days (from one to six in each month) similar observations were to be taken at short intervals in succession during so many hours as the altitude of the sun should exceed a certain assigned minimum. The observers remained at Leh nearly two years, and undoubtedly accomplished all that it was possible to do under the circumstances of the climate; but this proved to be little, if at all, superior to that which might have been obtained at some of the easily accessible stations of the outer Himalaya, and the total outcome of the twenty-three months' work was seven complete series recorded at short intervals, and sixty of of the tri-daily measurements, together with fifteen incomplete series of the former and ninety-five of the latter, which had been more or less interrupted by the obscuration of the sky. Moreover, the instrument by no means answered to the expectations of the inventor. Its chief apparent recommendation was the simplicity of its manipulation; but it was found to require careful attention to a number of minute and elaborate details in order to insure that the observations should be comparable *inter se*, and although the registers obtained were examined and discussed by Prof. Balfour Stewart shortly before his death, they were not found to lead to any definite conclusions of such importance as to justify their publication.

Notwithstanding the discouraging results of this expedition, the investigation has not been abandoned. After Sergeant Rowland's return from Leh, actinometric observations were carried on during the clear season at Mussoorie, and lately under Mr. Eliot's supervision at Simla, and the late Prof. Hill was engaged in the examination of some of this later work, when it was brought to a standstill by his premature death. It is, we believe, now contemplated to make actinometric and other physical observations a part of the future work of the Madras Observatory, and with that view, and also in the interests of astronomy, to transfer the Observatory to some suitable site on one of the lofty hill-groups of Southern India, a step long since recommended on general grounds.

From the first establishment of the Indian Meteorological Department, the sun-thermometer *in vacuo* has formed part of the equipment of every observatory; and every instrument, before being issued, has been subjected to a prolonged comparison with an arbitrary standard, in order to evaluate the mean effect of those irregularities which affect the readings of all instruments of this class, and in many cases amount to differences of 15° and more between thermometers constructed by the best makers. This precaution, however, has proved inadequate. It has long been known that the average readings of many of these instruments undergo a considerable decline in the course of a few years, and that in many cases the glass of the inclosing jacket becomes gradually opaque. During the year 1889, twenty-four observatories were each provided with three carefully compared instruments of different ages, and the observers were instructed to take the observations as accurately as possible. Mr. Eliot says:—

> "The results of the three instruments exposed under identical conditions were in the great majority of cases so widely discrepant as to show that the instrument, from defects in its construction, cannot, at least under the conditions of its employment in India, be relied upon to give consistent and reliable results."

The late Prof. Hill subjected these registers to a critical examination, and his conclusions, being based on the results of seventy-two instruments, may be taken as fairly representing the average behaviour of thermometers of this class. He says:—

"A few days' observations under identical conditions are not sufficient to determine the correction with any approach to accuracy. The thermometers are so variable in their indications, that, in one ordinary case that I worked out, it would seem that at least forty-four months' comparative readings would be required to furnish an average correction with a probable error of only one-tenth of a degree. The differences between the indications of two thermometers placed side by side are in very many instances subject to an annual variation, showing that the correction to a common standard cannot be made by adding or subtracting a fixed quantity, but that the amount of this correction is variable, and perhaps capable of being expressed as a function of the temperature indicated. The older instruments, even after correction, on the whole give lower readings than the new ones. Some of the latter, when compared with the oldest thermometers of the set, appear to fall off considerably in sensitiveness even in the short period of twelve months. . . . But sometimes an instrument two or three years old decreases in sensitiveness more rapidly than a perfectly new one; sometimes also an instrument, after remaining nearly constant in its indications for several months, as compared with the oldest of the set, suddenly shows a rapid and unaccountable falling-off in sensitiveness."

And he concludes:—

"The indications of the instruments are thus in most cases totally unreliable, and the observations comparatively worthless. The only possible exceptions I can see to this sweeping condemnation are observations made with instruments which have been in constant use for ten years or more, and which may perhaps be assumed to have arrived at a constant condition as regards sensitiveness."

Since the average duration of a sun-thermometer, under the conditions of Indian observatories, is only about three years, it is obvious that instruments that have stood the prescribed test can be but few. But it was with such a thermometer that were obtained the valuable results published by Mr. Hill in the Journal of the Asiatic Society of Bengal in 1883 and 1886, which afford the only direct evidence yet on record of an eleven-year variation of the solar heat.

The duration of sunshine has now been recorded at five Indian Observatories with the Stokes-Campbell sunshine recorder for periods of from four to seven years, and the average results are given in Mr. Eliot's Report, together with those of the year 1889. The stations are all in Northern India, one only, Calcutta, being within the tropics. Allahabad and Lahore show the highest proportion of sunshine, viz. 69 and 68 per cent. respectively of the possible maximum. Jeypore has but little less, viz. 65 per cent. Calcutta follows with 59 per cent., and Dehra, at the foot of the Himalayas, shows the lowest average, viz. 49 per cent. At St. Aubin's, in Jersey, the sunniest station in the British Isles, the proportion is 39 per cent. In the absence of any record from Southern India, it cannot be positively asserted that the Indo-Gangetic plain is the sunniest portion of India, but judging from the registers of cloud proportion, which are regularly kept at all Indian stations, there can be but little doubt that such is really the case.

Another kind of observations nearly related to the above are those of the temperature of the ground. These have been made at the same five Observatories that have furnished the sunshine records: at Calcutta since 1878, and at the other stations during periods of from four to ten years. One feature is common to all of them. In all cases the mean temperature of the ground is some degrees higher than that of the air, the excess varying, however, considerably at different stations, and at the same station in different years, as well as, of course, at different seasons of the year. This general fact was observed many years ago by the late J. Allen Broun at Trevandrum, and has also been known for some years in the case of Calcutta and Allahabad; and it was remarked by the late Prof. Hill that it is probably characteristic of hot climates in general. He considered it probable that there is

"a difference in the opposite direction between the air and ground temperatures in high latitudes; for, owing to the circulation of the atmosphere, and the constant mixing together of its several parts, the air temperature must be more uniform all over the earth than it would be were it determined for each place solely by the balance between insolation and loss of heat by radiation into space; while the temperature of the ground is more directly dependent on the balance between the gain and loss of heat by radiation."

I am not aware that this interesting speculation has hitherto been verified.

According to the present registers, Jeypore (where the ground consists of loose dry sand) shows the greatest excess of ground surface temperature, viz. 6°·3 [1] on the mean of the year; and at Lahore (where the ground is a sandy loam) it is as much as 5°·8. At Allahabad it appears to be about 3°·8, and at Calcutta 2°·7. It is therefore in a great measure dependent apparently on the dryness of the climate, since the mean annual rainfall of these four places is 25, 21, 38, and 62 inches respectively, and the mean relative humidities 50, 50, 61, and 77 per cent. of saturation. The ground temperatures here considered are those of the surface. At Calcutta the temperature increases rapidly with the depth, so that at 3 feet deep it is 1°·5 warmer than at the surface, and at 6 feet 1°·6 warmer. This is probably to be attributed to the decomposition of organic matter, with which a bed of fœtid quicksand at a depth of 40 or 50 feet is highly charged, and which, when freshly excavated, is distinctly warm to the touch.[2]

At other stations there appear to be some remarkable irregularities in the temperatures at different depths. Thus at Allahabad the average warmth of the ground decreases 1°·7 between the surface and the depth of 1 foot, and then increases 1°·2 to a depth of 3 feet; at Jeypore it decreases 3°·3 down to 1 foot, and then increases, but somewhat irregularly, by a total amount of 0°·6 to a depth of 20 feet; and at Lahore it decreases 1°·5 to a depth of 1 foot, and increases again 0°·7 to 3 feet. In the case of Allahabad, the temperatures of which were fully discussed in a memoir by the late Prof. Hill,[3] some of these minor irregularities

1 Most of the figures quoted in this paragraph differ from those given in Mr. Eliot's Report. In the Report the comparison is made between the mean ground temperature of a few years and that of the atmosphere deduced from three or four times as many, and in some cases the conditions of the Observatory have been changed. The figures in the text are derived from a comparison of the same years.

2 This bed extends apparently everywhere beneath Calcutta, and is the cause of great instability to the more ponderous edifices, of which the great Imperial Museum affords a striking example. In fact, in a certain sense, Calcutta may be said to be a floating city.

3 "Indian Meteorological Memoirs," vol. iv., Part iii., No. v., "On the Ground Temperature Observations made at the Observatory, Allahabad."

were shown to be the result of the flux and reflux of waves of heat as hotter or colder years alternated, the effects of which were by no means eliminated in the five or six years over which the record extended. But the remarkable diminution of temperature from the surface down to 1 foot cannot be thus explained. It appears at all the stations, for even at Calcutta there is an increase of only 0°·2 in the first foot below the surface, and then an increase of 1°·3 between 1 and 3 feet; and it appears to be independent of the character of the surface, which at Calcutta is grassy, and at Jeypore pure sand absolutely without vegetation. At Calcutta and Allahabad, the 1-foot thermometer as originally installed was found to have its temperature lowered by air-convection at night in the tube around the thermometer; but steps were taken to prevent this both at these and the other Observatories, and the invalidated registers were rejected. Yet it is difficult to imagine the existence of any cooling agency which should keep the temperature at 1 foot below the surface on an average 1° or 2° lower than either above or below that level, and the matter certainly requires further investigation.

The foregoing remarks deal with subjects which, although intimately connected with meteorology, lie somewhat apart from the ordinary field of meteorological observation. There is, however, very much in Mr. Eliot's Report, on the more familiar class of subjects usually dealt with by meteorologists that is well worthy of reproduction, especially the characteristic phenomena of Indian storms, which Mr. Eliot has made the object of his special study. These must be reserved for another notice.

The frequent reference in the foregoing paragraphs to the admirable work of the late Prof. Hill (and, after all, but few of the many subjects have been noticed to which his active mind contributed so largely) forcibly brings before me how great a loss has been sustained by Indian science in his premature death—a loss the more conspicuous in a country where the workers are so few and the field of research so large and fruitful. It is but a sad consolation to offer this slight tribute to the memory of a man who was as modest and amiable as he was able and accomplished as a devotee of science; but all who know his work will cordially re-echo the words of the Governor-General in Council—that the Meteorological Department of India "lost in him an officer whose industry, talent, and technical knowledge it will be hard to replace."

H. F. B.

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## *FRENCH MALACOLOGY.*

*Les Coquilles marines des Côtes de France; description des familles, genres, et espèces.* Par A. Locard. Pp. 384; 348 Figures in Text. (Paris: Baillière, 1892 [or rather 1891].) Also issued as tom. xxxvii. (1891) of the *Annales de la Société Linnéenne de Lyon.*

MORE favourably situated than these isolated and comparatively chilly shores, France possesses a Molluscan fauna which numerically is richer far than ours; whilst her political boundaries embrace portions of two terrestrial regions and two marine Molluscan provinces.

The land regions (Germanic and Lusitanian) yield probably something under 300 species. The last trustworthy work, that by Moquin-Tandon, describes 266 species—219 being terrestrial and 47 fresh-water forms.

The marine provinces are the Celtic and Lusitanian. The former includes the greater portion of the English Channel, and is common ground, therefore, to ourselves and our neighbours. The latter, especially the Mediterranean as distinguished from the Atlantic version of it, furnishes the French conchologist with his happiest hunting-ground. Nearly 1200 species are to be found in the Mediterranean, and another 150 (besides 418 common forms) on the Atlantic coast.

In contrast with this abundance of Molluscan life, all that we can boast is some 550 marine and 130 non-marine species.

Whilst, however, the material obtainable by the French conchologist is thus plentiful, the literature at his disposal for purposes of research and identification is by no means so complete as that which lies ready to the hand of his British *confrère.* The French Forbes and Hanley, or even Jeffreys, has yet to be compiled; no single work exists giving adequate descriptions, with synonymy, notes, and figures.

For the non-marine species Moquin-Tandon's careful work remains unsurpassed: for the whole subject the only approach yet made consists of the three volumes by M. Locard, of which the one now under consideration forms the last. The first two were issued under the title "Prodrome de Malacologie Française, Catalogue général des Mollusques vivants de France," and dealt respectively with the land, fresh- and brackish-water Mollusca, and with the marine. In these volumes the author gave no descriptions: a synonymy of each species, with references to the best descriptions and figures, and a list of the French localities, were all that appeared. In the present work M. Locard proposes to supply this deficiency, so far as the shells of the marine testaceous Gastropoda, Pelecypoda, and the Brachiopoda are concerned, by furnishing a concise—mostly too concise—description of each species, and a more detailed description, with a figure, of the typical forms of each genus and section, or "groupe" as he terms it, thereof. The synonymy and the bibliography are not repeated, and so each work remains incomplete without the other, and double reference is entailed—a process which is always vexatious.

Unfortunately, too, the subject is conceived exclusively from a shelly point of view; indeed, the fact that the shells ever had an animal origin and connection, is most skilfully concealed in the body of the work, and the 'nasty creature' is only alluded to when, in the introduction, it becomes necessary to refer to its habitat, or to describe the method of its elimination prior to the deposition of the all-precious tenement in the cabinet. To such a point is this persistent ignoring of the animal carried, that, in defining the topography of a bivalve shell, the customary and intelligible terms "right" and "left valve" are discarded in favour of the arbitrary designations of "upper" and "under," a nomenclature derived from their position when the shell is placed on its side upon the table with the umbones pointing towards the left.

The result is that, whilst in the majority of instances the *upper* is equivalent to the *left* valve, in *Nucula*, which is opisthogyre, the author has 'got the head where the tail should be,' and writes, for example, of *N. sulcata* (pp. 329-30): "région antérieure presque droite, très étroite; région postérieure très developpée, oblique." It is only fair to add that in *Donax*, thanks to the presence of the well-marked external ligament, this error is avoided.

The author's recognition in his introduction that every species is liable to variation, and his wise resolve not to cumber his book with trashy "varieties," founded merely on differences of colour or size, that have of late been so fashionable in certain quarters, is satisfactory; but it is greatly to be regretted that the process of elimination was not carried a step further. A very slight acquaintance with the animals, or even a cursory inspection of a fairly extensive series of examples of the shells of the individual species, would have been sufficient to convince any unprejudiced person that a very large percentage indeed of the "species" cited in this volume are but mere varieties, and unworthy of specific rank; at the same time we confess to some fear that all argument and instance would be lost on one who but lately has sought to divide so homogeneous a species as *Helix rufescens* into six! The principle adopted seems, in fact, to be, judging from numerous instances in the pages before us, to raise species into "groupes," and varieties into "species" (save the mark!). This is certainly the case in the genera *Nassa*, *Purpura*, *Mytilus*, &c.

It is little wonder under these circumstances, then, that M. Locard's three volumes should represent the French Molluscan fauna as including close upon 1500 marine and 1250 odd non-marine "species"! This may all be very magnificent; but it is not science!

The systematist will also have much cause to complain of the classification adopted, which is certainly not in accord with the latest views of the biologist. The extreme stickler for priority in nomenclature, of whom we have lately heard a good deal, will exclaim loudly against many of the names, though, since full reference to the authority is given in each case, there is perhaps not quite so much to find fault with, although the references are not always accurate.

On the other hand, we feel convinced that no one will approve certain arbitrary changes in the nomenclature, first proposed without comment or explanation in footnotes in the "Prodrome . . . Mollusques marins" (1886), but here introduced into the text itself. M. Locard appears to entertain special objection to the use of a substantive as a specific name, and converts it into an adjectival form, at the same time retaining the name of the original author as its sponsor! For example, *Purpura lapillus* appears as *P. lapillina; Nassa granum* is changed to *N. graniformis; Murex nux* into *M. nucalis; Aporrhais pespelicani* masquerades as *A. pelecanipes; Pholas dactylus* is turned into *P. dactylina.* We also find *Cassis Saburon* altered to *C. Saburoni;* and *Murex scalaroides* to *M. scalariformis.*

It would be interesting to learn on what principle, if any, these alterations are made, since some names that might apparently be equally objected to are left (fortunately) untouched; whilst M. Locard's own names are not always unexceptionable, as witness *Murex Brandariformis.*

If we comment thus strongly and at unmerited length upon this production, it is not because we mean to imply the work is altogether without merit, nor because we fail to recognize the honesty of the attempt. It doubtless to a certain extent supplies a want, and helps to fill a void: it is well printed and on good paper, with a good index, and some of the little illustrations are excellent.

The subject, however, is a worthy one, and deserving of broader, and, we regret to have to say it, more scientific treatment. This work, like Paetel's "Catalog" is a mere shell-collectors' book. What every student of the subject must desire to see is a really good treatise, worthy of the best traditions of French scientific work, and of the land of the illustrious Lamarck; one which shall do for systematic French malacology as a whole what Moquin-Tandon did for the terrestrial portion as known to him; and one that shall be done with the same conscientious care which distinguished that eminent naturalist, and which is characteristic of the work of Lacaze-Duthiers, himself one of the last of a long line of those distinguished biologists whom France has produced, and of whom she is so justly proud. $(BV)^2$.

## *MAN'S PLACE IN NATURE.*

*Nature and Man in North America.* By N. S. Shaler. Pp. 290. (London: Smith, Elder, and Co., 1892.)

PROF. N. S. SHALER, in the introduction to his new volume, gives a sketch of the plan of the work, and as there seems to be some want of connection between the different chapters, we prefer to quote the author's own words as to the object he has in view. He writes (p. vi.):—

"It seems to me to be the duty of every naturalist, particularly when he has adopted the tasks of the teacher, to use each fit occasion to show wherein he finds proof of a just confidence as to the relations of man to the creative power which works in Nature. By so doing, he may hope to help himself and his fellow-students to escape from the perplexity which has been brought about through the revolution in the opinions of men which modern science has induced. With this end in view, I shall devote the first four chapters of this book to a general statement concerning the effect of critical conditions of the earth on the development of organic life in general. It will be my aim to show that geographic changes and the consequent revolutions of the climate which our earth has undergone, though rude and in a way destructive, have nevertheless served the best uses of life, driving organic creatures by the whips of necessity upward and onward toward the higher planes of being.

"I shall give the latter half of this essay to the discussion of geographic influences upon man, endeavoring to show, at least in a general way, how the development of race peculiarities has been in large part due to the conditions of the stage on which the different peoples have played their parts. I shall endeavor to trace in outline the effect of the geographic conditions on the development of peoples in the past, and to make a somewhat careful study of these problems as they are exhibited in North America."

Less than half of Prof. Shaler's book is devoted to Nature and man in America, but this part is decidedly the best, and shows more signs of care than the earlier chapters. For these reasons, and because the title of the volume shows that the last hundred pages include the more important part, we will first deal with chapters v. to viii.

Beginning with a sketch of the dependence of man on his environment, the author proceeds to an account of the effect of environment on the development of various races. To the English reader one of the most interesting parts of chapter v. will be the account of the effect of the isolation and other physical peculiarities of Britain on the development of the English race.

In chapter vi. the author more especially deals with the dependence of the native races of North America on geographical and climatic conditions. This section leads by a natural transition to the competition between the white colonists and the Indians, and to the effect of barriers and strongholds in retarding or helping the gradual spread of the white races in North America.

Chapter vii. deals mainly with the relation of man to soils and climate, with the introduction of the negro race, and with the extent to which the negro and the white races are likely to compete.

In chapter viii., Prof. Shaler turns to the sparsely inhabited regions west of the Mississippi, and here he treats mainly of the capabilities for settlement of tracts still untried by white men. He speaks of the climatic conditions, of the probable value of the soils, of the reclamation of the arid regions by irrigation, and of the probable fitness of the Western States for permanent settlement by men of Aryan race : he concludes that this part of America is capable of sustaining an enormous population, and that white men can thrive in most parts of it.

To those who have not read Prof. Shaler's articles in *Scribner's Magazine*, we can recommend the last four chapters of his book as giving an interesting and readable account of man's relation to Nature in North America. The first four chapters we cannot praise : they seem to be largely made up of miscellaneous notes hastily put together with little arrangement and without careful revision ; they swell the bulk of the volume, but bear only remotely on the relation between Nature and man in North America.

Chapter i. treats mainly of the zoological and botanical provinces of the present day, and their dependence on physical barriers and on climate. These pages are full of interspersed suggestions as to what might have been if conditions had been different, but some of these suggestions do not seem to have been carefully thought out, and sometimes the author adopts irreconcilable views in other parts of the same volume. We find, for instance, numerous speculations as to the effect that would be produced by the diversion of the Gulf Stream, and, among others, the following passage, in which, after speaking of the lowering of the initial velocity that would follow from a submergence of the peninsula of Florida, the author observes (p. 21) :—

"It is mainly, if not altogether, to this initial velocity that we owe the efficiency of the Gulf Stream as a warmth-bringing current in high latitudes."

But on p. 129 we read :—

"It is a well-known fact that our oceanic streams are, in the main at least, a consequent of the movement which the air has in the trade-winds of the tropical district."

The author apparently does not observe that if the trade-winds are the main cause of the equatorial current, it is probable that the persistent south-westerly winds of the North Atlantic may also have much to do with the ocean current which follows the same course.

In chapter ii., Prof. Shaler speaks of the nature and origin of continents, development of life, mountain growth, saltness of the sea, &c. ; and in chapter iii., of the permanence of continents, including a sketch of the position of the shore-lines from pre-Cambrian times to the Glacial epoch. Chapter iv. deals with a great variety of subjects, such as the condition of the faunæ and floræ in Cambrian time, Croll's theory of the origin of coal-measures, conditions of continental growth in Europe, uniformity in past time of the composition of the atmosphere, and variations in the Gulf Stream.

Prof. Shaler, in his first four chapters, deals so largely with questions relating to the geographical distribution of animals and plants, that it surprises us to find a good many statements which more care in revision would certainly not have allowed to pass. Thus, speaking of local forms that must be developed through the long-continued competition of different assemblages brought into close proximity in a mountainous district, the author remarks (p. 27) that :—

"In a continent such as Europe, where a great diversity in the mountain systems favours the localization of life and the development of peculiar forms, the tendency is to develop in separate mountain strongholds particular species, and evolve their militant peculiarities until the forms are fitted to enter into a larger contention with their kindred species in less localized assemblages of life."

The example is most unfortunately chosen, for of all the continents Europe least illustrates the process ; one would have thought that no naturalist would have brought forward the Europe of the present day as a good illustration of the differentiation of species on mountains and in isolated valleys. Our Alpine flora and fauna, instead of varying greatly on the different chains, are more remarkable for their uniformity over all the continent. Our valleys seldom, if ever, contain plants and animals of local origin, for the Glacial epoch is of too recent a date for many local forms to be developed, and has affected Europe too seriously to allow many pre-glacial forms to survive in their original limited stations. Had Prof. Shaler pointed to the mountains of sub-tropical and tropical America, with their local species of humming-birds, we should not have objected. We have marked many other equally questionable statements, which it is surprising to find made on the authority of Prof. Shaler.

The occurrence of various statements of doubtful accuracy, the debatable character of much of the evidence, and the complicated nature of the questions dealt with, make us hesitate to endorse the author's opinion that this book "is particularly designed for the use of beginners in the study of geology." Speculations as to what might have been if conditions had been different are scarcely suitable for the beginner in any branch of natural science. The skilled naturalist or geologist, able to discriminate, may obtain useful hints from the present volume. C. R.

## OUR BOOK SHELF.

*Stones for Building and Decoration.* By George P. Merrill, Curator of Geology in the United States National Museum. (New York: John Wiley and Sons, 1891.)

This work deals almost exclusively with the building and ornamental stones of the North American continent, the references to similar rocks in Europe and elsewhere being usually meagre and sometimes disappointing. As an account of the rocks of the United States which are of economic importance as building materials, the work is, however, a very admirable one; and, as might have been expected in a treatise bearing the name of so well-known an authority as Mr. Merrill, the book is replete with valuable information both to the geologist and the architect.

Mr. Merrill gives, in the introduction to his work, an interesting sketch of the gradual substitution of stone for wood as a building material among the early settlers in New England, and then proceeds to sketch the distribution of the different varieties of building stones in the several States and Territories of the Union. The chapters which follow, on the minerals of building stones, and on the physical and chemical characters of the rocks which are employed in construction, are very admirably written; the illustrations of the microscopical structure of building stones, and the remarks on the nature and causes of disintegration in different varieties, being alike excellent.

In classifying building materials, Mr. Merrill very wisely adopts a combination of practical and scientific methods. Among the crystalline and vitreous rocks, he distinguishes, in the first place, those which are simple or made up of one mineral only—namely, steatite and soapstone, serpentine (including the verdantique marbles), gypsum (including alabaster and satin spar), and limestones with dolomites. In dealing with the compound rocks, or those built up of several different minerals, Mr. Merrill adopts the usual petrographical distinction of massive and schistose (or foliated) rocks. The former he divides into the four groups of rocks containing free quartz, rocks without quartz, but containing orthoclase felspar, rocks with plagioclase felspar, and rocks without felspar. The fragmental rocks are divided into the psammites (sandstones, &c.), the pelites (clays, &c.), the volcanic tuffs, and the rocks built up by organisms.

The chapters on the methods of quarrying, working, and testing building stones are especially admirable, and the illustrations of the great quarries of the United States, reproduced from photographs, are of great interest. The remarks on the processes which have been devised for the protection and preservation of building stones, and the tables giving the crushing strength, specific gravity, ratio of absorption, and chemical composition of all the chief varieties of building stone employed in the United States, cannot fail to be of great value to practical men. It would be hard to find a more admirable example of the value of exact scientific knowledge when applied to the treatment of economic questions than is afforded by the work before us.

*Les Champignons.* Par A. Acloque. (Paris: J. B. Baillière et Fils, 1892.)

The author of this book has found much to interest him in the study of his subject, and he communicates in a clear, pleasant style the leading facts and laws which have been brought to light by mycologists. Having presented in an introductory chapter some general considerations, he proceeds to deal with the subject from the anatomical, the physiological, and the economical points of view. Finally he gives a summary of mycological taxonomy. The book belongs to the "Bibliothèque Scientifique Contemporaine," and is in every way worthy of a place among the other volumes of the series.

*Theory of Heat.* By J. Clerk Maxwell. Tenth Edition. With Corrections and Additions by Lord Rayleigh. (London: Longmans, Green, and Co., 1891.)

This book is so well known, and has been of such good service to students, that it is scarcely necessary to do more than note the fact that a tenth edition of it has been issued. Only such corrections and additions have been introduced as seemed, in Lord Rayleigh's judgment, to be really called for. They are in great measure derived from Clerk Maxwell's later writings.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

### The Implications of Science.

Permit me, through your columns, to thank Mr. E. T. Dixon for his letter, which appeared in Nature of December 10, 1891, p. 125, concerning my lecture on the implications of science, and, very briefly, to reply to it.

He is very much mistaken in thinking that I place our knowledge of "the law of contradiction" and of "our own continuous existence" in the same category. I regard them as truths fundamentally distinct. The former is an abstract principle, the latter a particular fact. Since Mr. Dixon merely affirms without arguing, he must permit me to contradict him, and say that the law of contradiction *is* a necessary and *objective* truth—one that does *not* merely express a "verbal convention," and is *not* "of the nature of a definition." It is so objective that Omnipotence itself could not violate it—could not, *e.g.*, cause a creature to have at the same time both four and only three legs. But "our continuous existence" is so far from being a necessary truth that, if an Omnipotent Creator exists, there can be no impossibility in our annihilation. That we cannot be annihilated while we know we are actually existing is, of course, true; but that fact, so far from serving Mr. Dixon's argument, is but an example of the validity of the law of contradiction. We cannot at the same time be both "consciously existing" and "absolutely annihilated." My critic seems to be still in bondage to that subjectivism and nominalism wherein I was so long involved, and whence I only extricated myself slowly and with much trouble.

As to memory, I said that we may, as everybody knows, make mistakes, but that nevertheless we are as certain concerning some parts of the past as of the present. Most assuredly I am *quite* as certain that I read Mr. Dixon's letter as that I am now in the act of replying to it. Our confidence in our memory cannot depend upon induction, because, if we had it not at starting, we could make no induction or enumeration whatever.

My "implications of science" are truths, and not "purely verbal assertions," but I never affirmed any "peculiar certainty" for "mathematical conclusions." Helmholtz has never shown, to my knowledge, that two straight lines could ever inclose a space. Of course, if his supposed "dwellers on a sphere" chose, as Mr. Dixon says, to apply that term to what are *not* straight lines, different conclusions would follow. No one denies that two *curved* lines can be conceived of as inclosing a space.

Similarly, if Mr. Dixon's inhabitants of the Dog Star chose, as he again says, "to define four as $1 + 1 + 1$," then for *them* two and two would not be four. But who was ever so absurd as to suppose they would be? If any persons choose to give to the term "an angle" the signification we express by the words "a mutton chop," then certainly our conception of a triangle would not apply; for three such angles would not be equal to two right angles.

Mr. Dixon is good enough to instruct us that "the law of contradiction never tells us whether anything is or is not." But what man out of Bedlam would suppose that a statement of an abstract general law would inform us about a particular concrete thing? On the other hand, the law of contradiction does not tell us, and never by any possibility could tell us, "that the terms 'is' and 'is not' are not applicable to the same thing"—though by applying that abstract universal and necessary law to such things as "terms," we see that a term applicable to anything cannot at the same time be the very opposite.

Mr. Dixon says: "If anyone chooses to say a thing both 'is' and 'is not,' there is no law against his doing so, only if he does so he is not talking the Queen's English." But by so doing he breaks the law of reason, if not the law of the land; and, indeed, to act on such a principle when on oath in a court of law might, after all, have inconvenient consequences.

My critic is obliging enough to say in plain and simple terms: "Dr. Mivart is wrong in speaking of the objective absolute validity of the law of contradiction." To this I might content myself by replying: "*Quod gratis asseritur gratis negatur*"! But let us avoid the use of the terms "is" and "is not": they are not necessary for my purpose. Does Mr. Dixon really doubt whether, if he had lost one eye, he would still remain, after that loss, in the very same condition he was in before? If any-one does not see the objective impossibility of such a thing *everywhere* and *everywhen—i e.* if he does not apprehend the application of the law of contradiction—then he either does not understand the question, or his mental condition is pathological. The implications of science are implied. Men may pretend to doubt them, their own existence, or the objectivity of mathematical truths. But their practice shows their unfailing confidence in them on each occasion as it arises—as when cheated by false accounts, personally injured, or engaged in scientific research. When we enter the laboratory, we leave these follies outside. ST. GEORGE MIVART.

Hurstcote, December 22, 1891.

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WILL you allow me to say a few words in reference to four points in Mr. E. T. Dixon's indictment (NATURE, December 10, p. 125) of Mr. St. George Mivart?

(1) Mr. Dixon asserts that the law of contradiction "is not a *necessary* truth at all, it only expresses a verbal convention"—it "never tells us whether anything 'is' or 'is not.' It only informs us that the terms 'is' and 'is not' are not applicable to the same thing." But though it may be only a "verbal convention" that in "the Queen's English" *not* is the sign of negation, it is not a mere verbal convention that if *a* signifies the negation of A (whatever A may stand for), then A and *a* "are not applicable to the same thing"—as the law of contradiction asserts, and as Mr. Dixon himself allows. A highly abstract law that is concerned with the relations of propositions cannot, of course, tell us whether any particular thing exists or not—but then no one has ever expected that it should; and moreover, assertions (or denials) of the "existence" of particular objects are not the only "real" propositions (Mr. Dixon appears to be misled here partly by the ambiguity of *is*).

(2) Mr. Dixon says that the law of gravitation—like other laws suggested by particular experiences—depends ultimately upon induction *per enumerationem simplicem*; that is, upon an inference of the form *This A is X, that A is X, &c.* (= *Some A's are X*), ∴ *All A's are X* (for we can make nothing better out of an induction by simple enumeration). But this inference is merely an immediate inference, and moreover an illegitimate one; hence, according to Mr. Dixon's view, inductions have no logical justification whatever.

(3) Further, Mr. Dixon asserts that "the supposed peculiar certainty of mathematical conclusions is solely due to the fact that they are truisms," or "purely verbal assertions,"—by which I understand him to mean definitions. In answer to this I should maintain that the peculiar certainty of mathematical propositions, and the fact that here, by help of a single instance, we unhesitatingly conclude to the universal, are (as I have observed elsewhere) explicable by "the consideration that we here *see* at once the connection, which in other cases we *believe* on grounds very different from a perception of self-evident interdependence of attributes. When the equality of the interior angles of any one triangle to two right angles has been demonstrated to us, we infer without a moment's doubt that the same relation of equality may be asserted of the interior angles of *every* triangle; and this because we have *seen* that with the attributes signified by 'the interior angles of a triangle' there is bound up the attribute of 'being equal to two right angles.' We *believe* that, if a certain amount of arsenic has on some occasions produced death, it will always produce death, on the ground that the apparent likenesses are connected with unapparent likenesses; but we have not *seen* in this case (as we have in the case of the triangle) that there is a self-evident interdependence. And here we see why it is that, in the case of mathematical inductions, we do not need to use Mill's 'Inductive Methods.'"

(4) When Mr. Dixon goes on to say that, "*if* the inhabitants of the Dog Star defined 'twice,' 'two,' and 'four' as we do, then 'twice two' would be to them 'four'; but to say that it was so could only give verbal information," he may be refuted out of his own mouth. For he goes on to remark that, "if the people in the Dog Star chose to define four as 1 + 1 + 1, the so-called 'necessary truth' would not even be true!"; thus showing clearly that it is the facts signified, and not the words which signify them, that we are concerned with. According to Mr. Dixon, it would be (for me) a necessary truth that I have a headache, or am writing with a lead-pencil; while mathematical truths, in as far as "real," are obtained by induction, and are therefore not necessary. I hold, on the contrary, that mathematical truths, though obtained by induction, are "necessary"—that is, true under all circumstances—and that it is only by a confusion between "necessary" and "certain" that a statement of the apprehension of present fact can be called a "necessary truth." E. E. C. JONES.

Cambridge, December 14, 1891.

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### Supernumerary Rainbows observed in the Orkneys.

I INCLOSE a letter just received. The writer has charge of the anemometer formerly kept by the late Dr. Clouston. Dr. Clouston first drew my attention to the extraordinary bow seen at Kirkwall in 1871. My note is in the Quarterly Journal of the Meteorological Society, vol. i. p. 237.

ROBERT H. SCOTT.

Meteorological Office, 63 Victoria Street, S.W., December 31, 1891.

*Deerness Public School, Kirkwall, December* 28, 1891.

SIR,—On reading your very interesting work on "Elementary Meteorology," I find, on p. 201, reference made to "an extraordinary bow" which appeared at Kirkwall, November 13, 1871, which you explain by the reflection of the sun's rays from a water surface.

On Saturday, the 26th inst., at 3.20, when the sun was on the horizon, I saw a very distinct rainbow; there was no trace whatever of the secondary bow, but between where it ought to have been and the primary one there were several patches of what are called "supernumerary" bows. The only colour I saw distinctly was the red.

This lasted for about four minutes, when, finally, a second bow appeared just inside the primary, with the colours arranged as in the primary—not reversed, as the secondary. The space between the violet of the primary and this one was almost *nil*. The red next the violet of the primary was about as distinct as that of the primary. The orange and yellow were distinct also, but the others could hardly be seen. This was, no doubt, owing to the fading light of day, and to the dark colour of the clouds in the north-east, where the bows appeared. These lasted distinctly and complete for about one minute. The bows formed, as is well known, half a circle. The sun was setting behind land at the time, and the wind was blowing at the rate of forty-five miles, so that there could be no water reflection.

If I am not troubling you too much, would you kindly say if this is unusual, and if caused by the "interference" of rays?

Yours respectfully,

(Signed) M. SPENCE.

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### Aurora Borealis.

A FINE display of aurora was observed here on the evening of January 4. A faint northern glow was seen at 8.30, which quickly grew in brightness, and at 8.45, streamers in great quantity were visible. At 9 these became tinted with glowing red on their upper portions. After exhibiting lively motions for a quarter of an hour or so, the phenomenon settled down into a brilliant and steady arch of light, red on the outside and white within, resting on what appeared to be a bank of dark cloud. By eye estimate this arch would extend about 90 along the horizon, its apex over the north-north-west from 25° to 30° in height. The glow was still visible at 10 p.m., though considerably diminished in intensity. During the whole of the day a dry and frosty north-west wind prevailed, and the temperature at 10 p.m. was 28°. J. LOVEL.

Driffield, East Yorkshire, January 5.

### A Double Moon.

ON December 22, a well-defined double moon was seen 7m. before sunrise, which is here now at about 7. The fictitious moon was as a disk of white glass, through which the under-lapping part of the true moon could be seen. Atmospheric conditions being similar next morning, I watched for a repetition of the phenomenon, but after some abortive efforts, consisting of repeated, momentary, ill-defined projections of the moon's shape at a distance of three times the space occupied by her diameter, it was finally "given up." ROSE MARY CRAWSHAY.

Mentone, Hotel du Louvre, December 30, 1891.

## *ON THE RELATION OF NATURAL SCIENCE TO ART.*[1]

### II.

THERE is yet another direction in which art owes instructive disclosures to the progress of photography. In the year 1836, the brothers William and Edward Weber represented, in their celebrated work on the "Mechanism of the Human Locomotive Apparatus," a person in the act of walking, in those attitudes which, according to theoretical calculation, must occur successively during one step. Thence a strange fact became apparent. At the beginning and end of each step, while the body rests for a short time on both feet, the pictures agree perfectly with the ordinary way in which painters have been accustomed to represent walking persons. But during the middle of the step, while one foot is swinging past the other, the effect is highly eccentric, not to say ludicrous; the individual appears to be stumbling over his own feet like a tipsy fiddler, and nobody had ever been seen walking in such a way. On the last page of their book, the brothers Weber propose to test the correctness of their diagrammatic figures by the aid of Stampfer and Plateau's stroboscopic disks, in the shape of Horner's Dædaleum,[2] which has, strange to say, returned to us from America as a new invention, under the name of "zoëtrope" or even "vivantoscope"; but whether the proposal was carried out or not, does not appear.

However, William Weber lived to see his assertions thoroughly justified almost half a century later by instantaneous photography. It was first put into practice in 1872 by Mr. Eadweard Muybridge at the suggestion of Mr. Stanford, in order to fix the consecutive attitudes of horses in their different paces. The result was the same as in Weber's diagrammatic figures; pictures were obtained which nobody could believe to have seen in reality. On photographs of street life and processions the camera frequently surprised people in attitudes quite as odd as those attributed to them by the brothers Weber on theoretical grounds. The same is the case with the remarkable series of photographs of a flying bird during one beat of its wings, obtained by M. Marey with his photographic gun.

The explanation is known to be as follows: An object in motion, the speed of which varies periodically, leaves a deeper and more lasting impression on our mind in those positions which it occupies longest, while the impression is fainter and more fleeting in those through which it passes quickly. Apart from all knowledge of this law, a painter would never represent a Dutch clock in a cottage with the pendulum at the perpendicular, as every spectator would inquire why the clock had been stopped. The pendulum, having swung in one direction, necessarily stops for a moment while preparing to return in the other, and consequently its diverging position is more vividly stamped on our minds than those during which it passes through its position of rest with a maximum of speed. Precisely the same thing occurs with the alternately swinging legs of a man during the act of walking; the body remains longest in the position in which both feet support it, and shortest in that during which one foot swings past the other. We therefore receive scarcely any impression from the latter series of attitudes. We imagine a walking person, and painters accordingly represent him, in the interval between two steps, with both feet touching the ground.

In the case of a running horse, however, particular circumstances intervene. However rapid the succession of instantaneous photographs, we never obtain the usual image of a racing horse such as it appears in large numbers in the print-shops at the racing season, and such as we suppose we actually see in reality. It is different in the case of man; there among pictures obtained methodically or by chance, which have, so to speak, never been perceived by the naked eye, some will always occur which agree with the usual aspect of a walking person. The difference consists in this, that in a racing horse the interval of time, during which the fore-legs remain in complete extension, does not coincide with that during which the hind-legs are fully extended. Both these positions prevailing in our memory, they are subsequently blended into the traditional picture of a racehorse, whereas instantaneous photography fixes them successively. Consequently the traditional picture is wrong, and exhibits the horse in a position through which it does not even transitorily pass.

In the year 1882, an illustrated American paper brought out a picture of a steeplechase, in which all the horses are copied from Muybridge's photographs, in attitudes only visible to a rapid plate. This ingenious sketch was communicated to us by Prof. Eder in Vienna, in a pamphlet on instantaneous photography, and a stranger spectacle cannot well be imagined. The correctness of these apparently wrong pictures can, however, be proved by realizing the idea originally suggested by the brothers Weber, and integrating into a general impression the periodical motion which has been resolved, as it were, into differential pictures. This is done by gazing in the dædaleum at a series of photographs taken at sufficiently brief intervals from an object in periodical motion, or illuminating or projecting it momentarily during its rapid flight past the eye. The latter method has been put into practice by Mr. Muybridge himself in his "zoopraxiscope," and with us in the electric stroboscope by Mr. Ottomar Anschütz, a most skilful handler of instantaneous photography. In both instruments we see men and horses reduced to their natural mode of walking, running, or jumping—with one exception. The speed with which the slits of the dædaleum pass before the eye, or the period during which each picture is illuminated, being exactly the same for the whole series, the general effect produced is somewhat different from what it would be in real life. On the whole, however, the position in which both feet are touching the ground, prevails, because the motion of the legs slackens when approaching this position, so that the pictures follow each other more closely and almost coincide.

The series of instantaneous photographs taken by Mr. Muybridge and Mr. Anschütz from an athlete, during the performance of a muscular effort, are an inexhaustible source of instruction to students of the nude. Mr. Anschütz's stroboscope exhibits a stone- and a spear-thrower in all the different stages of their violent action: their muscles are seen to swell and slacken, until finally the missile is represented after its discharge, as it cannot move any faster than the hand in the act of hurling it.

[1] An Address delivered by E. du Bois-Reymond, M.D., F.R.S., at the annual meeting of the Royal Academy of Sciences of Berlin in commemoration of Leibnitz, on July 3, 1890. Translated by his daughter. This Address was first printed in the weekly reports (*Sitzungsberichte*) of the Berlin Academy, then in Dr. Rodenberg's *Deutsche Rundschau*, and lastly it was published as a separate pamphlet by Veit and Co., at Leipzig, 1891. Continued from p. 204.

[2] *Philosophical Magazine*, January 1834, 3rd Series, vol. ii., p. 36.

Animal painters will find equally useful the instantaneous photographs which Mr. Muybridge and Mr. Anschütz have obtained from domestic and wild animals.

Even on breakers in a stormy sea the camera has been employed with surprising success. In making use of these photographs, painters should, however, remember that the human eye cannot see the waves as a rapid plate does, and beware of producing a picture which in certain respects would be quite as incorrect as the clock which appears to have been stopped, or the man stumbling over his own feet.

Finally, the traditional representation of lightning in the shape of a fiery zigzag has been recently proved by Mr. Shelford Bidwell, on the evidence of two hundred instantaneous photographs, to be just as wrong as the traditional picture of a racing horse. Mr. Eric Stuart Bruce endeavours to vindicate the zigzag by taking it for a reflection on cumulus clouds;[1] it is, however, difficult to understand how its sharp angles can be accounted for in this way.

Prof. von Brücke has devoted a special essay to the rules for the artistic rendering of motion, which, together with the laws on the combination of colours, have at all times been unconsciously followed by the great masters.

A cultivated and artistically gifted eye, supported by sufficient technical knowledge, was always able to compose genuine works of art in photography, as Mrs. Cameron long ago proved. In our days, Dr. Vianna de Lima has shown how this branch of art has been advanced and extended by instantaneous photography. It contributes a solution to Conti's question in Lessing's "Emilia Galotti"—whether Raphael, had he been born without hands, would not the less have been the greatest of painters. The photographic plate has been described as the true retina of the philosopher; and one might add, of the artist, if it were not unluckily almost colour-blind. Unfortunately, theoretical reasons which experience will hardly contradict render it highly improbable that the expectations still entertained by artists and the general public, with regard to photography in natural colours, will ever be realized.

Whether photography does not act unfavourably on the reproductive arts, such as engraving, lithography, and woodcutting, by taking their place to an increasing extent, remains to be proved. Its fidelity is certainly such as, in a certain sense, to lower the value of the original drawings of old masters, by making them common property. An exhibition, arranged by one of our art-dealers several years ago, of the best engravings of the "Madonna della Sedia," together with a photograph from the original, first opened our eyes to the extent to which each master has embodied in his copy his own individual conception. But even were photography to cause such a retrogression in the reproductive arts, of what importance would that be, compared to the immeasurable services which, as a means of reproduction itself, it renders art, by disseminating the knowledge and enjoyment of artistic work of all kinds and periods? No one can fully estimate and appreciate what it has done to beautify and enrich our life, whose memory does not reach back into those, as it were, prehistoric times, "when man did not yet travel by steam, write and speak by lightning, and paint with the sunbeam."

Is it credible, after all this, that there can be any need of mentioning the benefits derived by art from the study of anatomy? Has not the "Gladiator" of the Palazzo Borghese given rise to the conjecture that there were anatomical mysteries among the Greek artists, as the only means by which they could have obtained such complete mastery of the nude? Was it not through incessant anatomical studies that Michael Angelo acquired the knowledge necessary for the unprecedented boldness of his attitudes and foreshortenings, which are still a source of admiration to anatomists such as Prof. Henke and Prof. von Brücke? Has not provision been made by all Governments that methodically encourage art, to afford to students an opportunity of training the eye on the dead subject to note what they will have to distinguish under the living skin? Have not three successive teachers, who afterwards became members of this Academy, been intrusted with this important duty in Berlin? Finally, do we not possess excellent compendiums of anatomy specially adapted to the use of artists?

And yet the most renowned English art critic of the day, who in his country enjoys the reputation and veneration of a Lessing, and who lays down the law with even more assurance—Mr. John Ruskin—explicitly forbids his pupils the study of anatomy in his lectures on "The Relation of Natural Science to Art,"[1] given before the University of Oxford. Even in the preface he deplores its pernicious influence on Mantegna and Dürer, as contrasted with Botticelli and Holbein, who kept free from it. "The habit of contemplating the anatomical structure of the human form," he continues, "is not only a hindrance but a degradation, and has been essentially destructive to every school of art in which it has been practised." According to him, it misleads painters, as for instance Dürer, to see and represent nothing in the human face but the skull. The artist should "take every sort of view of animals, in fact, except one—the butcher's view. He is never to think of them as bones and meat."

It would be waste of time and trouble to refute this false doctrine, and to set forth what an indispensable aid anatomy gives to artists, without which they are left to grope in the dark. It is all very well to trust one's own eyes, but it is better still to know, for instance, how the male and female skeleton differ; why the kneecap follows the direction of the foot during extension, and not during flexion of the leg; why the profile of the upper arm during supination of the hand differs from that during pronation; or how the folds and wrinkles of the face correspond to the muscles beneath. Campe's facial angle, though superseded for higher purposes by Prof. Virchow's basal angle, still reveals a world of information. It is hardly conceivable how, without knowledge of the skull, a forehead can be correctly modelled, or the shape of a forehead such as that of the "Jupiter of Otricoli" or the "Hermes" be rightly understood. Of course fanciful exaggeration of anatomical forms may lead to abuse, as is frequently the case with Michael Angelo's successors; however, there is no better remedy against the Michael Angelesque manner than earnest study of the real. Finally, a superficial knowledge of comparative anatomy helps artists to avoid such errors as an illustrious master once fell into, who gave the hind-leg of a horse one joint too many; or such as amuses naturalists in the crocodile ot the Fontaine Cuvier near the Jardin des Plantes, which turns its stiff neck so far back that the snout almost touches the flank.

We are, however, less surprised at Mr. Ruskin's opinions, on learning that he similarly prohibits the study of the nude. It is to be confined to those parts of the body which health, custom, and decency permit to be left uncovered, a restriction which certainly renders anatomical studies somewhat superfluous. It is satisfactory to think that decency, custom, and health allowed the ancient Greeks more liberty in this respect. Fortunately, the English department of the Berlin International Exhibition four years ago has convinced us that Mr. Ruskin's dangerous paradoxes do not yet generally prevail, and that we are free to forget them in our admiration of Mr. Alma Tadema's and Mr. Herkomer's paintings. Nor could Mr. Walter Crane's charming illustrations, the

1 NATURE, vol. xlii. pp. 151 and 197.

1 "The Eagle's Nest: Ten Lectures on the Relation of Natural Science to Art," 1887.

delight of our nurseries, have been produced without disregard of Mr. Ruskin's preposterous doctrine.

In the same lecture Mr. Ruskin opposes with the utmost vehemence the theory of evolution and natural selection, and the æsthetic rule founded on it, according to which vertebrate animals should not be represented with more than four legs. "Can any law be conceived," he says, "more arbitrary, or more apparently causeless? What strongly planted three-legged animals there might have been! what systematically radiant five-legged ones! what volatile six-winged ones! what circumspect seven-headed ones! Had Darwinism been true, we should long ago have split our heads in two with foolish thinking, or thrust out, from above our covetous hearts, a hundred desirous arms and clutching hands, and changed ourselves into Briarean Cephalopoda."

Obviously, this false prophet has no notion of what in morphology is called a type. Can it be necessary to remind a countryman of Sir Richard Owen and Prof. Huxley that the body of every vertebrate animal is based on a vertebral column, from which it derives its name, expanding at one end into a skull, reduced to a tail at the other, and surrounded before and behind by two bony girdles, the pectoral and the pelvic arches, from which depend the fore and hind limbs with their typical joints? The very fact that palæontology has never known any form of vertebrate animal to depart from this type is in itself a striking argument in favour of the doctrine of evolution, and against the assumption of separate acts of creation; there being no reason why a free creative Power should have thus restricted itself. So little will Nature deviate from the type once given, that even deformities are traced back to it by teratology. They are not really monstrosities; not even those with a single eye in the middle of the forehead, which Prof. Exner takes to be prototypes of the Cyclops, Flaxman being certainly mistaken in representing Polyphemus with three eyes—two normal ones which are blind, and a third in the forehead. Real monstrosities are those winged shapes of Eastern origin, invented by a riotous fancy while art was in its childhood: the bulls of Nimrûd, the Harpies, Pegasus, the Sphinx, the griffin, Artemis, Psyche, Notos of the Tower of Winds, the goddesses of Victory, and the angels of Semitic-Christian origin. A third pair of extremities, (Ezekiel even admits a fourth) is not only contrary to the type, but also irrational in a mechanical sense, there being no muscles to govern them. In the "Fight with the Dragon," Schiller has happily avoided giving his monster the usual pair of wings; and in Retzsch's illustrations its shape agrees so far with comparative anatomy as to recall a Plesiosaurus or Zeuglodon returned to life and changed into a land animal; indeed, the resemblance between those animals and the mythical dragon has led to the question whether the first human beings might not have actually gazed upon the last specimens of those extinct animal races.

An abomination closely related to the winged beasts are the Centaurs, with two thoracic and abdominal cavities, and a double set of viscera; the Cerberus and Hydra, with several heads on as many necks; and the warm-blooded Hippocamps and Tritons, whose bodies, destitute of hind limbs, end in cold-blooded fish—an anomaly which already shocked Horace. If they had at least a horizontal tail fin, they might pass for a kind of whale. The cloven-footed Faun is less intolerable; from him our Satan inherited his horns, pointed ears, and hoofs, on account of which Cuvier, in Franz von Kobell's witty apologue, ridicules him as an inoffensive vegetable feeder. The heraldic animals, such as the double eagle and the unicorn, have no artistic pretensions, and their historical origin entitles them to an indulgence they would otherwise not deserve.

It is a remarkable instance of the flexibility of our sense of beauty that, though saturated with morphological principles, our eye is no longer offended by some of these monstrosities, such as the winged Nike and the angels; and it would perhaps be pedantic, certainly ineffectual, to entirely condemn these traditional and more or less symbolical figures, though in fact the greatest masters of the best epochs have made very slight use of them. There are, however, limits to our toleration. Giants, as they occur in our Gigantomachia, with thighs turning half-way down into serpents, which consequently rest, not upon two legs, but upon two vertebral columns ending in heads and endowed with special brains, spinal cords, hearts, and intestinal canals, special lungs, kidneys, and sense-organs—these are, and always will be, the abhorrence of every morphologically trained eye. They prove that, if the sculptors of Pergamon surpassed their predecessors of the Periclean era in technical skill, they were certainly second to them in artistic refinement. Perhaps they should be excused on the plea that tradition bound them to represent the giants with serpent legs. The Hippocamps and Tritons, with horses' legs and fish-tails, which disfigure our Schlossbrücke, date from a period in which classical taste still reigned supreme, and morphological views were still less widely diffused than at present. Let us therefore pardon Schinkel for designing or at least sanctioning them, as well as the winged horse and griffin on the roof of the Schauspielhaus, for which he must also be held responsible. But our indignation is justly aroused when a celebrated modern painter depicts with crude realism such misshapen male and female monsters wallowing on rocks, or splashing about in the sea, their bodies ending in fat shiny salmon, with the seam between the human skin and the scaly cover scantily disguised. Such ultramarine marvels are worshipped by the crowd as the creations of genius; then what a genius Höllen-Breughel must have been!

Curiously enough, the inhabitants of the caves of Périgord, the contemporaries of the mammoth and musk-ox in France, and the bushmen whose paintings were discovered by Prof. Fritsch, only represented as faithfully as possible such animals with which they were familiar; whereas the Aztecs, a people of comparatively high civilization, indulged in fancies of more than Eastern hideousness. It would almost appear as if bad taste were associated with a middle stage of culture.

With regard to the teaching of anatomy in schools of art, the above proves that it should not be confined to human osteology, myology, and the doctrine of locomotion alone, but that it should also endeavour—and the task is not difficult—to familiarize the student with the fundamental principles of vertebral morphology.

Botanists should in their turn point out such violations of the laws of the metamorphosis of plants as must, no doubt, frequently strike them in the acanthus arabesques, palmettos, rosettes, and scrolls, handed down to us from the ancients. From obvious reasons, however, these cannot affect them as painfully as malformations of men and animals, being in themselves repulsive to natural feelings, would the comparative anatomist. Moreover, a beneficial revolution has recently taken place in floral ornament. The displacement of Gothic art by the antique during the Renaissance had led to a dearth of ideas in decorative art. The rich fancy and naïve observation of nature, displayed upon the capitals of many a cloister, had gradually given way to a fixed conventionalism, no longer founded on reality. Rauch, at Carrara, in search of a model for the eagles on his monuments, was the first to turn to a golden eagle, accidentally captured on the spot, instead of to one of the statues of Jupiter. It was then that, towards the middle of the century, decorative art began to shake off its fetters, and, combining truthfulness with beauty, returned to the study and artistic reproduction of the living plants with which we are surrounded. In this respect the Japanese had long ago adopted a better course, and to them we have since become indebted for many suggestions. Thus highly welcome additions were made to the decoration of our homes, and the ornaments of female dress.

In one direction, however, it will be observed that men of science readily dispense with a strict observation of the laws of nature in art, at the risk of being charged with inconsistency. In works of art, both ancient and modern, flying and soaring figures occur in thousands. These, no doubt, sin against the omnipotent and deeply felt laws of gravity quite as much as the most loathsome creations of a depraved imagination against the principles of comparative anatomy, familiar only to a few adepts. Nevertheless they do not displease us. We prefer them without wings, because wings are contrary to the type, and could be of no use to them without an enormous bulk of muscle. But we do not mind the Madonna Sistina standing on clouds, and the subordinate figures kneeling on the same impossible ground. "Ezekiel's Vision" in the Palazzo Pitti is certainly less acceptable. But to quote modern examples, Flaxman's "Gods flying to the aid of the Trojans," or Cornelius's Apocalyptical riders, and Ary Scheffer's divine Francesca di Rimini, with which Doré had to enter into hopeless competition, are not the less enjoyable because they are physically impossible. We do not even object to Luini's representing the corpse of St. Catharine carried through the air by angels, or to that of Sarpedon, in Flaxman's drawing, by Sleep and Death.

In an interesting lecture on the "Physiology of Flying and Soaring in the Fine Arts," Prof. Exner endeavours to explain why illustrations of men and animals in this condition, though impossible and never visible in real life, strike us as familiar and natural. I do not profess to agree entirely with the solution which he appears to prefer. His idea is, that our sensations in swimming, and the position in which we see persons above us in the water when diving, are similar to what we would experience in flying. Considering what a short time the art of swimming has been generally practised by modern society, especially by ladies, who nevertheless appreciate flying figures just the same, doubts arise as to the correctness of Prof. Exner's explanation. To attribute the feeling to atavism in a Darwinian sense, dating from a fish-period in the development of man, seems rather far-fetched. And do not the sensations and aspect of a skater come much nearer to flying or soaring than those of a swimmer?

Another remark of Prof. Exner, which had also occurred to me, appears more acceptable. It is, that under especially favourable bodily conditions we experience in our dreams the delicious illusion of flying. For

"in each soul is born the pleasure
Of yearning onward, upward, and away,
When o'er our heads, lost in the vaulted azure,
The lark sends down his flickering lay,
When over crags and piny highlands
The poising eagle slowly soars,
And over plains and lakes and islands
The crane sails by to other shores."[1]

Who would not long, like Faust, to soar out and away towards the setting sun, and to see the silent world bathed in the evening rays of eternal light far beneath his feet? And when we long for anything, we love to hear of it, and to see it brought before us in image. Our desire to rise into the ether, and our pleasure in "Ascensions" and similar representations, are further enhanced by the ancient belief of mankind in the existence of celestial habitations for the blessed beyond the starry vault; a belief which Giordano Bruno put an end to, though not so thoroughly but that we are constantly forgetting how badly we should fare, were we actually to ascend into those vast, airless, icy regions, which even the swiftest eagle would take years to traverse before alighting on some probably uninhabitable sphere.

We are now inclined to reverse the question, and to ask: What have sculpture and painting been able to do for science in return for its various services? With the exception of external work, such as the representing of natural objects, not much else than the results obtained by painters as to the composition and combination of colours, which, however, have not exercised as strong an influence on chromatics as music on acoustics. It is known that the Greeks possessed a canon of the proportions of the human body, attributed to Polycletes, which, as Prof. Merkel recently objected, unluckily only applied to the full-grown frame, to the detriment of many ancient works of art. The blank was not systematically filled up till the time of Gottfried Schadow. This canon has since become the basis of a most promising branch of anthropology—anthropometry in its application to the human races.

If the definition of art were stretched so far as to include the power of thinking and conceiving artistically, then indeed it would be easy enough to find relations and transitions between artists and philosophers, though, as we remarked at the beginning, their paths diverge so completely. But it is not so certain that natural science would necessarily be benefited by an artistic conception of its problems. The aberration of science at the beginning of this century known as German physiophilosophy owed its origin quite as much to æsthetics as to metaphysics, and the same erroneous principles guided Goethe in his scientific researches. The artistic conception of natural problems is in so far defective, as it contents itself with well-rounded theoretical abstractions, instead of penetrating to the causal connection of events, to the limits of our understanding. It may suffice in cases where analogies are to be recognized by a plastic imagination between certain organic forms, such as the structure of plants or vertebrate animals; but it fails altogether in subjects such as the theory of colours, because it stops short at the study of what are supposed to be primordial phenomena, instead of analyzing them mathematically and physically. Prof. von Brücke subsequently, by the aid of the undulatory theory, traced to their physical causes the colours of opaques on which Goethe founded his theory of colours, and which to this day have tended rather to darken than to enlighten certain German intellects. The difference between artistic and scientific treatment becomes very evident in this example.

Nevertheless, it cannot be denied that artistic feeling may be useful to scientific men. There is an æsthetic aspect of experiment which strives to impart to it what we have termed mechanical beauty; and no experimenter will regret having responded to its demands as far as was in his power. Moreover, the transition from a literary to a scientific epoch in the intellectual development of nations is accompanied by a tendency to brilliant delineation of natural phenomena, arising from the double influence of the setting and the dawning genius. Instances thereof are Buffon and Bernardin de Saint-Pierre in France, and Alexander von Humboldt in Germany, who, to his extreme old age, remained faithful to this tendency. In the course of time, this somewhat incongruous mixture of styles splits into two different manners. Popular teaching preserves its ornamental character, while the results of scientific research only claim that kind of beauty which in literature corresponds to mechanical beauty. In this sense, as I long ago ventured to indicate here on a similar occasion, a strictly scientific paper may, in tasteful hands, be made as finished a piece of writing as a work of fiction. To strive after such perfection will always repay the trouble to men of science; for it is the best means of testing whether a chain of reasoning, embracing a series of observations and conclusions, is faultlessly complete.

And this kind of beauty, which often graces, unconsciously and unsought for, the utterances of genius, will no doubt be also found to adorn Leibnitz's writings.

[1] Translation of Goethe's "Faust," by Bayard Taylor.

## *CHRONOPHOTOGRAPHY, OR PHOTOGRAPHY AS APPLIED TO MOVING OBJECTS.*[1]

THIS subject forms the basis ot a very interesting article, in the *Revue Générale des Sciences*, by Prof. Marey, who explains a new method for the analysis of the movements of various bodies that are under consideration, more especially in biological than in physical science. Our readers may remember a book that appeared in the year 1882, entitled "The Horse in Motion," published under the auspices of Leland Stanford. Mr. Stanford, wishing to study the relative positions of the feet of horses in rapid motion, employed Mr. Muybridge, who was then noted as a very skilful photographer, to carry out a series of experiments. The success which rewarded their endeavours revealed so much that seemed of importance, that he determined to make a complete study of the subject, and with this intention employed Dr. J. D. B. Stillman, to whom he intrusted the undertaking.

The method the last mentioned adopted was very similar to that employed later by Mr. Muybridge, the differences being that he only made use of one series of cameras, and that the plates were exposed by the breaking of threads by the moving object. The revolving disk was also in vogue then, for taking movements of running dogs, flights of birds, &c., only it was not used to obtain the movements of the horse, as it was found extremely difficult to set the apparatus in motion at the exact moment required, and to regulate it to the speed of the horse.

It is important, next, to refer to the results obtained by Mr. Muybridge in his later experiments, carried out at the University of Pennsylvania, which were published in a large book containing all the series of photographs. The following is a brief account of the method he used.

It consisted in the employment of three batteries, each containing twelve cameras. The object of working with *three* batteries was to enable him to obtain photographs from three points of view simultaneously, and the manner in which he arranged them was as follows. One battery was set parallel to the track along which the object to be photographed moved, so that its image would be formed on each plate successively as it passed before the lenses; and since the distance between the object and each camera was constant, only one focus was required. Placed at right angles to this track, and directed up and down it, were fixed respectively the two other batteries, and the cameras in these were so adjusted as to have in their field of view the same series of positions as seen in the first battery, only of course from two different standpoints; but since in this case the distance between the object and the cameras was always varying, each of the latter had to be specially adjusted for its own focus.

The instantaneous shutters of all the cameras were connected by wires to a set of twelve metal studs situated on the circumference of a disk, each stud being fastened to a set of three wires, each of which comes from the first camera in each battery, the second set from the second cameras, and so on.

A second disk, placed close by, and carrying a brush, was made to rotate, the brush coming in contact with each of the studs in turn. By this means, a series of currents was sent to these groups of three cameras intermittently; and, as each contact was made, three shutters were simultaneously released—one in each of the series—giving a group of three synchronous pictures of the object that was moving on the track, showing the fore, hind, and lateral views.

One of the first attempts of Prof. Marey consisted in placing on each foot of the moving animal elastic cushions, which were connected with a chronograph by means of flexible tubes. As each foot came in contact with the ground, a record of the impact was obtained, from which interesting results were deduced relating to the peculiarities of the succession of steps, and the time-intervals separating them.

Having referred above to the earlier experiments, we will now mention the very recent work carried out by him. The method that he here adopts differs considerably from his first endeavour, and also from that employed by Muybridge and Stillman. Instead of using many cameras, and therefore many plates, he works with one camera and one plate, and it is on this plate that he produces his *series* of photographs. The objects that he wishes to study move in front of a dark background, which is situated directly opposite the camera. Fitted to the camera is a large disk with openings in it, and which is capable of quick or slow rotation in a vertical plane.

During the passage of *one* of these openings before the lens, the moving object has its image cast on the photographic plate, and is there recorded: as soon as the aperture has passed, no light can fall on the plate unti the next opening comes opposite. As soon as this arrives, another picture is taken in the same way, but, during the interval that has just elapsed, the object, having changed its place, forms its image naturally on another part of the plate. By continuing this process, one can easily see that, on the plate being developed, a series of successive images will be seen extending from one side to the other.

With a very slow-moving object, this method cannot be applied so well, unless an intermittent rotation be given to the disk, as we should have a series of overlapping images quite undistinguishable from one another. The following illustration (Fig. 1) is an example of a

FIG. 1.—Arab horse at full gallop.

picture obtained by using a continuously revolving disk. Between each exposure it will be seen that the horse has not even travelled its own length, but only a little over half, so that the mingling of all the images results in a picture that is useless for purposes of study. The question which was raised from such results as shown in the above figure may be formulated thus: How is it possible to reduce the surface of the object, and yet be able to record the movements of its principal members photographically? The following very artful device, which is shown in the next illustration (Fig. 2), exemplifies the manner in which Prof. Meyer solved the question. By dressing the object in black, employing a dark background, and placing on the members, the movements ot which he wished to investigate, white lines and spots, he was able to increase the number of exposures per second without introducing overlapping, and to record the successive positions taken up by them.

We must mention here that the experiments were only carried out with a man as object; if a horse had been taken, it would have been necessary to have dressed it in black, and to have put the distinguishing marks on *either* one of the fore *or* hind legs, and not on both at once; otherwise there would have been two complete series of images recorded on one plate at the same time, and overlapping each other.

[1] We are obliged to the editor of the *Revue Générale des Sciences* for permission to use the illustrations reproduced in this article.

In another illustration we have an interesting set of attitu les assumed by a running man dressed in this costume

FIG. 2.—Man dressed in black, and consequently invisible when passing before a dark background. The white lines which are shown on his arms, legs, and on the sole of one foot are the only parts the successive phases of which can be recorded.

(Fig. 3). The lines in the figure indicate the sequence of positions in which the above-mentioned distinguishing

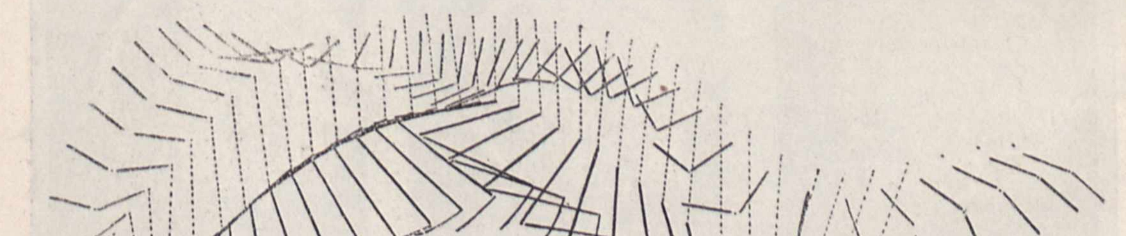

FIG. 4.—Analysis of the phases of a running high jump. Taken on a fixed plate (twenty-five images per second).

marks are found at each exposure; and the resulting diagram also shows that the number of images capable of being photographed in a given time is very largely increased, while the overlapping is only slightly apparent.

Another case is that shown in Fig. 4, which represents a man jumping. The several phases of movement are here also well discernible, and the images were recorded at the rate of twenty-five per second.

Although the method employed above suited admirably for such purposes as we have mentioned, yet Prof. Marey found that he could not use it without modification for all the cases to which he wished to apply it. The apparatus which he then constructed, and of which a complete detailed account is given in his article, is shown in Fig. 5, and

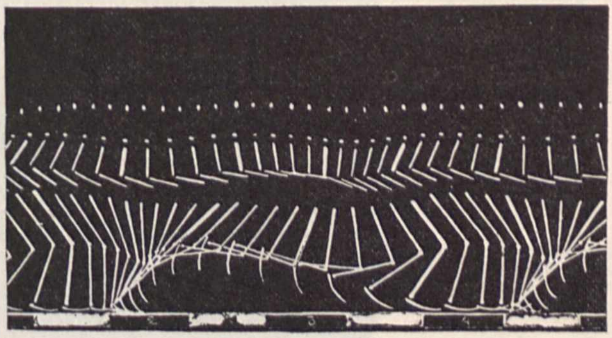

FIG. 3.—Images of a runner, showing the white marks which represent the attitudes of the principal members. Chronophotography on a fixed plate.

differs in many particulars from the former one, the chief characteristic about it being that films are employed which are capable of rapid lateral movement. By means of this moving film it is possible to obtain, in a very short space of time, a large number of separate pictures, for, during each exposure, a new part of the film is brought opposite the lens of the camera, held there, and then slipped along. The apparatus itself is of a most ingenious construction, and the three most important parts consist of a driver, a clamper, and an elastic arm.

In the figure, L represents the driver, and it is due to its action that the motion of the paper is produced; it consists of a wooden cylinder, the surface of which is covered with india-rubber, and round which the band of paper passes when made to travel from one bobbin to the other.

In the case of the clamper, marked C′ in the drawing, its action is to press the paper against the side of the chamber during each exposure, and this is carried out by means of a series of cams placed on a small circular horizontal disk (marked C). It might be supposed that, with very short exposures obtained by means of a very rapid shutter, the clamper would be found quite unnecessary, as the horizontal distance traversed by the band of paper during an exposure would be practically *nil*, or at any rate small enough to produce no visible effect on the

lodoce, . . . passing on to scorpions and spiders, and then to shrimps, lobsters, . . ."

Although, at the first glance, one cannot quite see how Muybridge's principle, or, at any rate, a slight change of it, could be applied to interpret the gait of the centipede, yet in Prof. Marey's instrument Prof. Lankester will, we hope, find just the kind of apparatus to carry out the various suggestions to which he referred. In fact, the instrument has already been employed in producing pictures representing aquatic locomotion, and the follow-

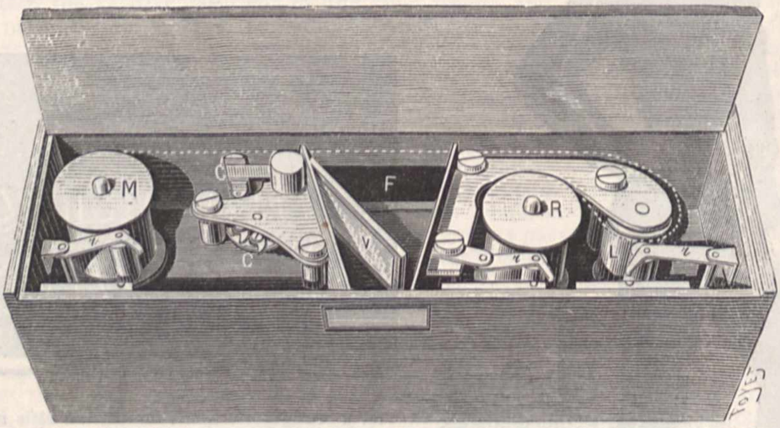


FIG. 5.—The chamber in which the images are formed, with the lid raised. M and R are the drums on which the films are rolled off and on respectively; *r*, *r*, *r*, small rollers pressing the film on the cylinders; L, the driver, with its pressing cylinder; F, the aperture for the admission of the image; V, ground glass with hinged motion. The dotted line indicates the path of the band of film; C′ and C, the clamper and its cam, which produces the intermittent action of this band.

picture produced; but this is not the case, for Prof. Marey says that by experience the only good images obtainable were made with the use of the stop.

Owing to the quickness of the action of the driver, and the instantaneous blow given by the clamper to the paper at each exposure, an elastic arm is made to come into play to relieve the paper of any strain or force to which it may be subjected.

Many readers may remember the very interesting

ing illustration (Fig. 6) shows a Medusa swimming, while Fig. 7 shows the phases of movement that a star-fish undergoes in order to turn itself over.

The interesting point is displayed in the last four pictures of the series. Counting from the bottom, No. 5 shows the position just before one of his "rays" leaves the ground and just when he begins to grip it with the other two; having this grip, he is able to dispense with the use of the other ray, and so raises the other three as

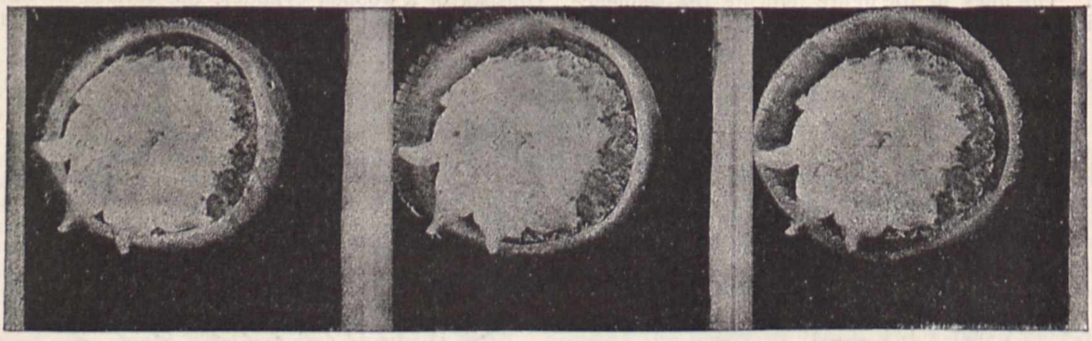

FIG. 6.—Medusa swimming horizontally, whilst moving away rom the apparatus (negative).

article in a former number of NATURE (vol. xl. p. 78), written by Prof. Ray Lankester, relating to the Muybridge photographs. Towards the end he says: "For my own part I should greatly like to apply Mr. Muybridge's cameras, or a similar set of batteries, to the investigation of a phenomenon more puzzling even than that of 'the galloping horse.' I allude to the problem of 'the running centipede.'" He then goes on to say: "I am anxious to compare with these movements the rapid rhythmical actions of the parapodia of such Chætopods as Phyl-

shown in No. 6. No. 7 illustrates the position of unstable equilibrium as obtained by means of the preceding movements, while the last one exemplifies stable equilibrium again.

The time occupied in the above evolutions is not so short as may be supposed, but lasts sometimes from ten to twenty minutes, the intervals in time between two of the above pictures being about two minutes.

The movements of the eel have also been studied in this way, and the series of movements represented in

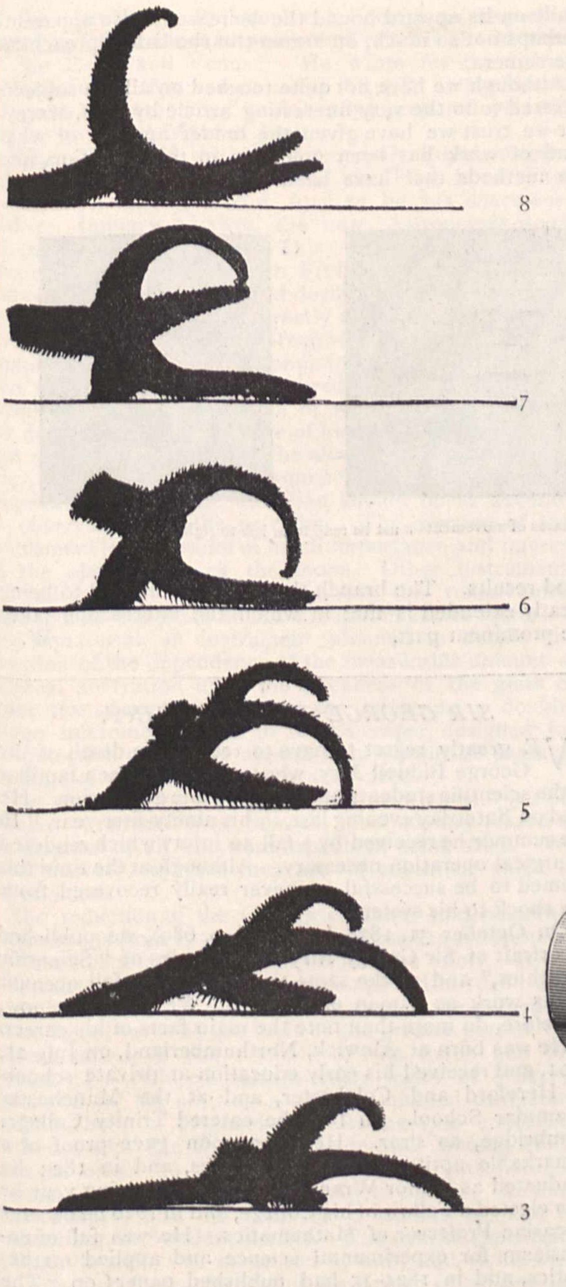


FIG. 7.—Series of phases performed by a star-fish in turning itself over.

Fig. 8, illustrating an eel swimming horizontally, brings out clearly the wave produced by the effect of the undulatory movement of the body, propagating from the head to the tail.

In observing the movements of many other different species of serpents, both in and out of water, Prof. Marey says: "La reptation des uns et la natation des autres présentent de grandes analogies avec la natation de l'anguille, mais nous n'y avons pas trouvé la même régularité des mouvements."

But in the study of the movements of objects as small

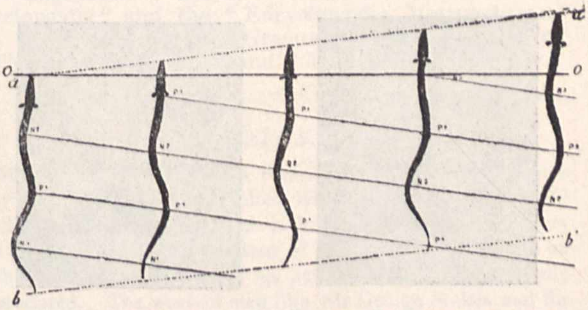


FIG. 8.—Eel swimming in a horiz ntal plane. The horizontal line *oo* shows plainly the inclination of those lines which join the crests and troughs of the waves formed by the body, so that the velocity of progression of the animal is expressed by the inclination of the line *oa*.

as these, Prof. Marey does not here conclude his observations, but has constructed a special piece of apparatus, as shown in Fig. 9, for recording the movements of microscopical objects. The general working of this apparatus can be seen at a glance. C is the large condenser which concentrates all the light from some artificial source on to the small holder *p*, in which the object is placed. The micrometer objective marked O,

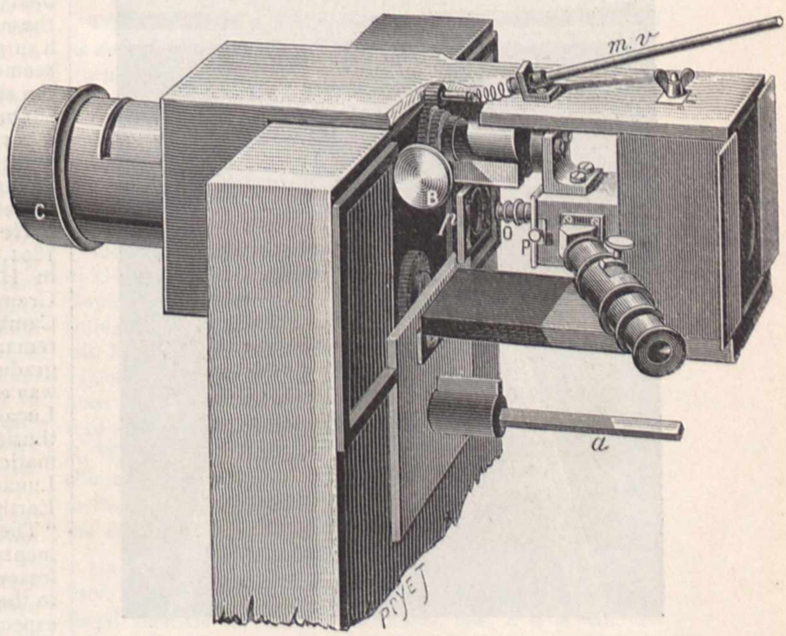


FIG. 9.—Special piece of apparatus for studying the movements of microscopical objects.

is placed on the other side of this holder, but in the axis of the condenser. The micrometer head B regulates the distance of *p* from O, and can be moved either by the rod *mv*, or by its milled head. An important adjunct to the instrument is the microscope that is placed obliquely at the side of the camera; by its means, and by that of a small prism that can be placed in the axis of the light by simply pulling or pushing the knob P, the object about to be photographed can be observed just before exposure, which insures the centrality of its image on the sensitive film.

The extension of this branch of chronophotography, if taken up and developed, may be of great use to medical science, for many occurrences happen where such an apparatus as the above would be invaluable. One of the examples done by this method is shown in Fig. 10, and illustrates the movements of Vorticellæ, which retract their stalks in spiral fashion. Many other proposals, not yet carried out, are mentioned by Prof. Marey, and include the production of photographs showing the movements of blood corpuscles in the capillary tubes, the intimate actions of the contraction of the fibre of the muscles, and the waves which pervade them

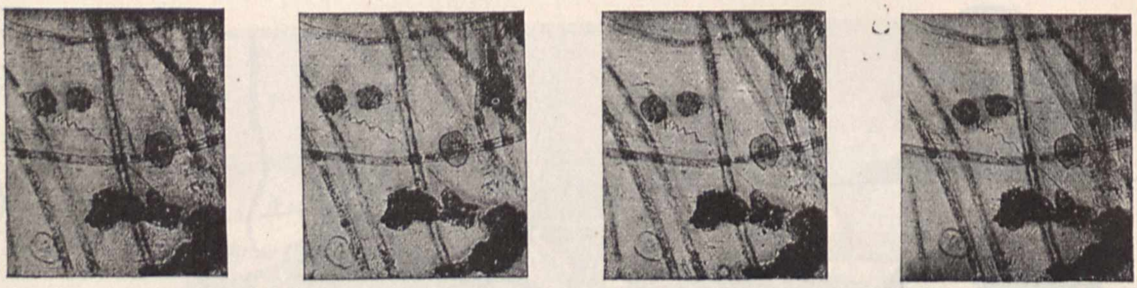

FIG. 10.—Showing the movements of Vorticellæ. The phases of movements must be read from left to right.

Prof. Marey also applies chronophotography to movements of objects in physical as well as in biological science, but although several cases are mentioned, we will only refer here to the instance he gives of the falling ball (Fig. 11).

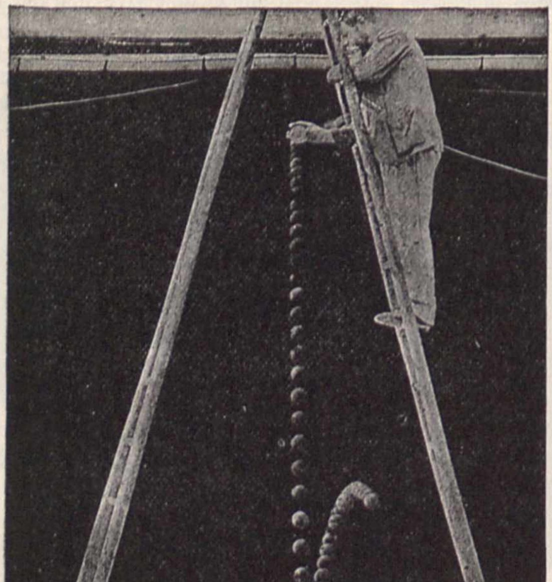

FIG. 11.—Series of positions taken up by a falling ball studied by chronophotography on a fixed plate.

The intervals between each image of the ball, although different in space, are equal in time, and the illustration brings out clearly the gradual increase of the velocity; while on its upward bound the decrease is also apparent, perhaps not so much, on account of the ball approaching the camera.

Although we have not quite touched on all the subjects referred to in the very interesting article by Prof. Marey, yet we trust we have given the reader an idea of what kind of work has been going on in this direction, and the methods that have been adopted to produce such good results. The branch that we look forward to being greatly extended is that in which the microscope takes the prominent part.

W.

## SIR GEORGE BIDDELL AIRY.

WE greatly regret to have to record the death of Sir George Biddell Airy, whose name has been familiar to the scientific students of more than one generation. He died on Saturday evening last, in his ninety-first year. In the summer he received by a fall an injury which rendered a surgical operation necessary. Although at the time this seemed to be successful, he never really recovered from the shock to his system.

On October 31, 1878 (vol. xviii. p. 689), we published a portrait of Sir George Airy in our series of "Scientific Worthies," and at the same time we gave a full account of his work as a man of science. We need not now, therefore, do more than note the main facts of his career.

He was born at Alnwick, Northumberland, on July 27, 1801, and received his early education at private schools in Hereford and Colchester, and at the Manchester Grammar School. In 1819 he entered Trinity College, Cambridge, as sizar. Here he soon gave proof of a remarkable aptitude for mathematics, and in 1823 he graduated as Senior Wrangler. In the following year he was elected a Fellow of his College, and in 1826 he became Lucasian Professor of Mathematics. He was full of enthusiasm for experimental science and applied mathematics, and in 1824–25 had published papers on "The Lunar and Planetary Theories," on "The Figure of the Earth," on "The Undulatory Theory of Optics," on "The Forms of the Teeth of Wheels," and on "Escapements." After his appointment to the Lucasian Professorship, he continued to make important contributions to the knowledge of such subjects, devoting himself with especial ardour to the study of undulatory optics, which was at that time a new field of research.

He was elected Plumian Professor of Astronomy in 1828, a position with which was associated the directorship of the Astronomical Observatory. Here he superintended the erection of several instruments, and—in accordance with the example set by Maskelyne, and followed by Bessel and Struve—introduced a thoroughly efficient system for reducing the observations, which were printed annually. He also carried on theoretical studies. In 1831 he published in the Transactions of the Cambridge Philosophical Society an important paper on "The Inequality of Long Period in the Motions of the Earth and Venus." He wrote for the British Association in 1832 a most useful "Report on the Recent Progress of Astronomy," and in 1833 prepared valuable papers on "The Mass of Jupiter."

When Mr. Pond, the sixth Astronomer-Royal, resigned his office in 1835, Lord Auckland, the First Lord of the Admiralty, appointed Prof. Airy to be his successor; and on January 1, 1836, the new Astronomer-Royal entered upon his duties. This was a position which accorded in all respects with Prof. Airy's wishes, and in the course of the long period during which he held it he not only maintained, but greatly increased, the fame of the Royal Observatory at Greenwich as one of the most important centres of astronomical investigation. To him the Royal Observatory owed its equipment with a series of new instruments, all of which were made from his designs, while some were of his own invention. The first of these instruments—the altazimuth—was set up in 1847, the object of the instrument being to secure that observations out of the meridian should be as accurate as observations in the meridian. The erection of this instrument led to results of much importance and interest in the observation of the moon. Other instruments erected were a new meridian-circle, the reflex-zenith-tube (put in the place of the Troughton zenith-sector), a new equatorial, an instrument planned to decide the question of the dependence of the measurable amount of sidereal aberration upon the thickness of the glass or other transparent material in the telescope, a double-image micrometer, and an orbit-sweeper, designed for the detection of comets approaching perihelion passage, the time of which cannot be exactly fixed.

The observations were made at Greenwich with perfect regularity, reduced most carefully, printed, and placed at the disposal of all who were capable of using them. We need scarcely say that they are of enormous value to astronomers.

The reduction of the Greenwich lunar and planetary observations from 1750 had been proposed to astronomers by Bessel as a task well worthy of serious effort. It was undertaken by Airy in 1833, and completed in 1848; and, as we have stated in our previous article, the reductions thus effected serve as the basis of the greater part of our present tables of the motions of the moon and the planets. He reduced various other series of observations, and by his untiring activity stimulated competent students, both in England and elsewhere, to undertake kindred work. He also gladly undertook labours which were in other ways fitted to advance astronomical science. In 1842 he went to Turin to observe the total solar eclipse, and he went for a similar purpose to Gothenburg, in Sweden, in 1851. The eclipse expedition to Spain in 1860 was organized by him, and to his care was intrusted the equipment of the British expedition for observing the transit of Venus in 1874.

Soon after his appointment to the position of Astronomer-Royal, Airy proposed to the Government that magnetical and meteorological observations should be made at Greenwich; and in 1838 his scheme was adopted, the result being that a vast number of data have since been accumulated. We need only refer to such work as his useful experiments on the deviation of the compass in iron ships; his researches on the density of the earth by observations in the Harton Colliery; and his investigations in connection with the standards, the fixing of the breadth of railways, and the introduction of a new system for the sale of gas.

His scientific eminence secured for him the position of President of the Royal Society, which he held from 1871 to 1873. He became a C.B. in 1871, and a K.C.B. in 1872. He was medallist of the French Institute, of the Royal Society (twice), of the Royal Astronomical Society (twice), and of the Institution of Civil Engineers. The Paris Academy of Sciences made him one of its eight "Associés étrangers," and he was an honorary member of many scientific Societies both at home and abroad.

Among the works of Sir George Airy is a little book entitled "Popular Astronomy," which has passed through many editions. He was also the author of "Treatise on Errors of Observation," "Treatise on Sound," "Treatise on Magnetism"; and of contributions to the "Penny Cyclopædia" and the "Encyclopædia Metropolitana," on such subjects as "Gravitation," "Trigonometry," "Figure of the Earth," and "Tides and Waves."

## NOTES.

MEN of science were much pleased to learn on New Year's Day that a peerage of the United Kingdom had been conferred on Sir William Thomson. This is the second time Lord Salisbury has done honour to a President of the Royal Society, and on both occasions the wisdom of his action has been very generally appreciated. The work of men like Sir George Stokes and Sir William Thomson brings with it, of course, its own reward; but it is good for the nation that the value of their services should be officially and adequately recognized.

THE following will be the Presidents of Sections at the Edinburgh meeting of the British Association:—Mathematics and Physical Science, Prof. Arthur Schuster; Chemistry and Mineralogy, Prof. Herbert McLeod; Geology, Prof. Charles Lapworth; Geography, Prof. James Geikie; Economic Science and Statistics, the Hon. Sir C. H. Freemantle; Mechanical Science, Prof. W. C. Unwin; Biology, Prof. W. Rutherford; Anthropology, Prof. Alexander Macalister.

THE Institution of Electrical Engineers will hold the first of its meetings during the current year on Thursday, the 14th inst., when the President, Prof. W. E. Ayrton, F.R.S., will deliver his inaugural address.

AT a Congregation held at Cambridge on Monday, the Duke of Devonshire was elected to the Chancellorship of the University, without opposition, in succession to his father. The formal installation will take place in the Easter term.

THE general meeting of the Association for the Improvement of Geometrical Teaching is to be held at University College, Gower Street, on Saturday, January 16. At the morning sitting (11 a.m.), the reports of the Council and the Committees will be read, and the new officers will be elected. After an adjournment at 1 p.m., members will reassemble for the afternoon sitting (2 p.m.), at which the following papers will be read:—On Laguerre's dictum concerning direction, by Prof. R. W. Genese; on the geometrical interpretation of fallacy in elimination, by Prof. R. W. Genese; on the use of Horner's method in schools, by Mr. E. M. Langley. All interested in the objects of the Association are invited to attend.

DR. RICHARD PFEIFFER, the son-in-law and assistant of Prof. Koch, and head of the Scientific Department of the new Royal Institute for Infectious Diseases, has, it is stated, discovered the influenza bacillus. Full particulars are to be published shortly. Meanwhile, according to a Reuter's telegram, it is already known that "six attempts at transplantation of the microbe have been made, and have been attended with complete success, thus proving the genuine character of the discovery."

THE International Sanitary Conference met at Venice on Tuesday. This is the sixth occasion on which the Conference has assembled. Its first meeting was held at Paris in 1851. This was followed by gatherings at Constantinople in 1860, at Vienna in 1874, at Washington in 1881, and at Rome in 1885.

The New Year's address to the members of the Sanitary Inspectors' Association was delivered on Saturday last by Dr. B. W. Richardson, F.R.S., the President. He offered them the congratulations which, he said, they deserved to receive from everybody who was interested in the cause of sanitation on the immense advance which they, as sanitarians, had made during the past year. They occupied a better position in the public estimation than they ever did, and they stood on a firmer foundation from the circumstance that the Board of Trade had given them permission to enrol themselves as a Society limited by guarantee, which really was the same as if they were incorporated. By that progress they had gained a step which placed them in a most enviable position. It was very rarely that any Society so young as theirs received such a public recognition in so short a time. They were now practically a professional body, such as existed in the Church, the law, and physic.

The eighth of the series of One Man Photographic Exhibitions at the Camera Club is now being held. It consists of photographs by Mr. J. Pattison Gibson. The pictures will be on view for about six weeks.

A scientific Commission has been appointed by the Government of Costa Rica for the investigation of various classes of phenomena in that country which have hitherto been inadequately studied. The Commission consists of Prof. H. Pittier, who acts as Director, Luis Chable, who offered his services for archæological research, G. K. Cherrie, zoologist, and A. Tonduz, botanist.

The organizing joint committee of the Essex County Council and the Essex Field Club have issued syllabuses of courses of instruction in several subjects, in addition to those to which we lately referred. Mr. J. T. Cunningham, of the Marine Biological Laboratory, Plymouth, is to lecture on the natural history of marketable sea-fishes, and on oysters and oyster-culture. Mr. H. N. Dickson will give three courses of lessons on elementary practical meteorology for fishermen, farmers, and sailors.

In order to determine the local distribution and altitude of the aurora, a considerable number of observers is necessary, so distributed throughout the area covered by the observations as to secure as full information as possible with regard to the extent to which the aurora is present or absent. To aid and increase the number of observers in this field Mr. M. A. Veeder has issued some blanks and a circular, and he says :—"It is desirable to have as many observers is possible co-operate in the plan described in the accompanying circular and blanks. Auroras are likely to become more frequent during the coming year, affording a special favourable opportunity for systematic observation." It is stated in the instructions that the chief observations required are the time and zenith distance of all the prominent features. If only a single observation can be made each evening, the best hour for it is between 9 and 10 o'clock p.m. Observers must remember that in a case like this "every little helps," and the results that have been already obtained warrant the belief that by concerted effort information of practical value may be secured.

At the meeting of the French Meteorological Society on Dec. 1 last, M. Angot presented the results of temperature observations made during the year 1890 on the Eiffel Tower at 515 feet, 646 feet, and 990 feet above the ground. During the night, the temperature increases up to a mean height of about 500 feet, then decreases, slowly at first, and afterwards more rapidly ; at about 1000 feet the mean decrease of temperature is about 1°·4 per 328 feet (100 metres). During the day, the temperature decreases constantly from the ground upwards ; in the lower strata the decrease is slower in winter than in summer. In the latter season it amounts to 2°·5 per 328 feet ; but above 500 feet the rate of decrease does not show a decided annual variation ; the amount is about 1°·6 per 328 feet. It is worthy of remark that at a height of 984 feet (300 metres) in open air, the decrease of temperature is extremely rapid, both during the night and during the day, and nearly approaches the theoretical value of the law of the adiabatic expansion of gases. M. L. Teisserenc de Bort gave an account of Dr. Hildebrandsson's observations on the motions and heights of clouds. A study of their direction showed that, first, the air which moves in a spiral towards the centre of a depression, having attained a considerable height, moves away from the centre and converges towards the centres of the maxima, and redescends towards the earth by a centrifugal motion. Second, in the northern hemisphere, the direction of an upper wind is always somewhat to the right of that of the lower wind. Thirdly, the mean direction of the upper currents is from west to east in temperate regions, and in the opposite direction in tropical regions. Dr. Hildebrandsson has also published charts of the direction of cirrus clouds, accompanied by theoretical isobars at an altitude of 4000 metres, as proposed by M. Teisserenc de Bort, which show that the motions of the cirrus are quite in accordance with those isobars.

In the *Anales* of the National Geographical Institute of Costa Rica, vol. iv., Señor H. Pittier has published the results of meteorological observations made at San José during 1889, together with a summary of rainfall and earthquake observations for the years 1866–80. These observations are valuable, as data from Central America are scanty. A comparison of the rainfall curve with the earthquake phenomena shows that the greater number of shocks occur in the months of maximum rainfall—viz. in May and September.

At a recent meeting of the Chemical Section of the Franklin Institute, Philadelphia, a letter from Mr. M. Carey Lea was read, transmitting to the Section the gift of a collection of his published papers on allotropic forms of silver and a set of specimens of the various modifications of the element which he had prepared. These specimens are greatly valued by the members of the Section.

A very large part of the literature of experimental psychology is taken up with the discussion of the psychophysical measurement-methods ; and in many cases the psychological question at issue has been lost sight of, in the interest of the methods themselves. One of these, which has been the subject of a good deal of controversy—the method of double stimuli—is finally discredited by Prof. F. Angell in the new part of Wundt's *Philosophische Studien*. Prof. Angell's experimental results are especially interesting, on the positive side, in their relation to Weber's law. Two other articles in the number contain valuable experimentation. Dr. G. Martius proves the erroneousness of the common opinion that there goes along with increasing intensity of a simple clang a continuous decrease of the length of the time of reaction to it. For practised and attentive reagents the time remained the same, within wide differences of stimulation. Dr. A. Kirschmann tabulates the results of his photometric determination of the relations which obtain between "dark" and "light" surfaces, in respect of brightness. It is pointed out that such results furnish in one direction a criterion for art-criticism.

Mr. C. J. Murphy, who has been charged by the U.S. Agricultural Department with the introduction of Indian corn as a human food into Europe, has made a report to Secretary Rusk on his work in Great Britain. In it he reviews the conditions which seem likely to encourage the use of this cereal food in Great Britain and other parts of Europe. Secretary Rusk has caused to be prepared for publication, in conjunction with Mr. Murphy's report, a chapter upon the value of maize as food, by Dr. H. W. Wiley, chief chemist of the Department, in which are shown the chemical composition of maize, and its relative value for food purposes in comparison with other cereals. There is also a chapter, prepared by the assistant statistician, Mr. B. W. Snow, under the direction of the statistician, offering some additional observations as to the possibility of extending the use of this cereal among the people of Europe as a human food, and presenting a number of statistical tables showing the yield and value of the American corn crop.

AN important *Bulletin* on the forest and mineral wealth of Brazil has lately been issued by the Bureau of the American Republics. The forests of Brazil abound in woods of great value, some of the finest of which are said to be entirely unknown in Europe. With regard to mineral resources, Brazil is not less fortunate. Scientific explorers have found great deposits of coal and iron, and have also proved that the country possesses copper, manganese, and argentiferous lead ore. There are also mines of gold and diamonds. Diamonds are co-extensive with the gold deposits, and, like that metal, are most abundant in Minas Geraes, where they have been found since 1789. The most important locality known for the production of these gems is the district of Diamantina, in the above-named State. They are found in Parana, in the gravels of the River Tibagy, and in the bed of streams dry during the summer. Since the discovery of diamonds at the Cape of Good Hope, the Brazilian production has greatly diminished. As regards iron, the State of Minas Geraes abounds with it. It is not found in veins or strata, buried deep in the earth, but in enormous beds, often lying at the surface, or in mountain masses. These vast deposits are worked only by small scattered furnaces, charcoal being used in the reduction of the ore. Of these small furnaces there are five groups, producing about 3000 tons annually, the product being used in the surrounding districts in the manufacture of articles of home consumption, such as hoes, shovels, picks, drills, nails, horseshoes, &c. In the State of San Paulo are found deposits similar to the best Norwegian ore; and one of the mines is worked by the Government establishment near the village of Sorocaba. This establishment has two furnaces, and produced in one year about 790 tons of pig-iron. The ore has about 67 per cent. of iron. In Santa Caterina, not far from a harbour accessible to the largest vessels, are vast deposits of hæmatite, containing, on an average, 30 per cent. of manganese, and 20 to 30 per cent. of iron. In the State of Goyaz, as in Minas Geraes, are found enormous masses of the ore itaberite.

PROF. GEORGE H. WILLIAMS contributes to the latest of the Johns Hopkins University Circulars an interesting account of a geological excursion in Maryland by students of that University in May 1891. The land area of Maryland is approximately 10,000 square miles, which may be in round numbers divided between the three topographically and geologically distinct provinces as follows: (1) *Central Maryland*, called the Piedmont Plateau, with 3000 square miles between the Catoctin Mountain on the west and a line drawn from Washington to Wilmington on the east, exhibits a gently rolling country of moderate elevation and relief. This is composed of the most ancient and contorted rocks—highly crystalline toward the east, and semi-crystalline toward the west. (2) *Western Maryland*, or the Appalachian Mountain province, embracing the 2000 square miles west of Catoctin Mountain. This region is formed of the entire sequence of Palæozoic strata thrown into a series of regular folds or undulations. (3) *Eastern and Southern Maryland*, belonging to the coastal plain, has about 5000 square miles of undisturbed and unconsolidated strata, in nearly horizontal position, and representing the accumulations from the Jurassic to the present. In the course of each year an effort is made to give students of geology at the Johns Hopkins University a practical acquaintance with the petrography, palæontology, structure, and topography of each of these three provinces by a series of excursions which are conducted exclusively for this purpose. In the excursion in May the route of the party lay along the section through the Appalachian Mountains exposed by the gorge of the Potomac River.

IN the new number of the *Internationales Archiv für Ethnographie* there is a learned and well-arranged paper, by C. M. Pleyte, on the use of the sumpitan and bow in Indonesia. A line may be drawn passing over Flores, to the east of Manggarai and Buru, to the west of Halma-Lera, and to the east of the Philippines, exactly marking the limit of the use of the bow. To the east of this line the bow is in general use, while to the west it is found only sporadically. A second line traced westward of Sumba, eastward of Sumbawa, to the south and east of Celebes, and to the east of the Philippines, marks the limit of the use of the sumpitan, which is found nowhere to the east of it. Between these two lines—on the islands of Sumba, West Flores, Saleyer, Buton, Buru, the Sula Islands, the Banggai Archipelago, and the Sangi and Talaut Islands—neither sumpitan nor bow are known. The author points out that these two limits correspond very closely with the line accepted by Dr. Brandes, separating the eastern from the western branch of the Malayo-Polynesian languages. It appears, therefore, that those natives who use the sumpitan form one family in point of language, and that the like is the case with those who use the bow.

DR. R. W. SHUFELDT contributes to the Proceedings of the U.S. National Museum two interesting prints of Havesu-pai Indians. The prints are reproductions of photographs which were taken several years ago by Mr. B. Wittick, formerly a photographer in the employment of the U.S. Geological Survey. The Havesu-pais live in one of the grandest cañons in Arizona, occupying their primitive lodges along the bank of the stream that passes through it. They are a dying race, and very little is known about them. The styles of their lodges are well shown by Dr. Shufeldt's plates, which also display the varied costumes of the men, women, and children, and the peculiar forms of their baskets. The fashion in which the hair of the women and girls is "fixed" seems to point to affinities between the Havesu-pai and the Pueblan Indians.

IN the new number of *Insect Life*, Dr. C. V. Riley directs attention to what he calls a new herbarium pest. In September 1890, a number of small Geometrid larvæ were found by the botanists of the U.S. Department of Agriculture infesting certain dried plants in the Department herbarium, and especially those which had been received from Mexico and Lower California. The fact that the insect has appeared on dry plants from the comparatively arid western regions may, Dr. Riley thinks, furnish a clue to its original habit. It would seem possible, if not probable, that it normally feeds on the dead or dry plants of Mexico and adjacent arid regions, and that it has simply adapted itself to the somewhat similar conditions prevailing in herbaria. It is a new species, and for the present may be placed in the Acidalinæ.

MR. W. VERNER writes to the current number of the *Zoologist* that the Kentish plover, like the stone curlew, or thickknee, is being rapidly exterminated in the county from which it derives its name, by collectors and so-called "naturalists," who, with walking-stick guns, in and out of season, destroy all they can approach. "These gentry," says Mr. Verner, "do more harm even than they imagine, for I have come across many small plovers and other birds which have been ineffectually 'peppered,' and have gone away to die. Still oftener I have found nests of the ringed and Kentish plovers which have been trampled on by these uncouth marauders in their clumsy and ever eager attempts to 'annex' everything they can in the least possible time." The editor of the *Zoologist* pertinently asks why the Wild Birds Protection Act is not put in force.

AT the meeting of the Linnean Society of New South Wales on November 25, Mr. Fred. Turner exhibited specimens of *Telopea oreades*, F. v. M. (narrow-leaved form), the Victorian Waratah, [collected at the Fitzroy Falls, N.S.W., the most northern habitat yet recorded for the plant; said to be very rare. Also three fungus-smitten grasses from the interior: *Eriochloa punctata*, Hamilt., *Panicum Mitchelli*, Benth. (two valuable pasture grasses—in the case of the second of these the first occasion on which he had seen fungoid growth on it), and *Aristida ramosa*, R.Br., one of the "three awned spear grasses," a noxious plant. To the presence in fodder of parasitic fungi such as these, the fact that many sheep died so mysteriously at times was, Mr. Turner thought, sometimes possibly attributable.

MESSRS. WHITTAKER AND CO. have made arrangements with the editor of *El Telegrafista Español* for the translation into Spanish of Mr. Preece's work upon "The Telephone." The book has already been translated into French and German. The same firm will publish shortly, in a cheap form, Mr. A. R. Bennett's papers on the telephoning of great cities and the electrical parcel exchange system.

WE are glad to welcome the first number of *The Annals of Scottish Natural History*, a quarterly magazine, with which is incorporated *The Scottish Naturalist*. It is edited by J. A. Harvie-Brown, J. W. H. Trail, and W. E. Clarke, and published by David Douglas, Edinburgh. The periodical ought to play an important part in stimulating the study of natural history in Scotland.

AN important botanical work has been planned by T. Durand, *aide-naturaliste* at the Botanic Gardens of Brussels, and H. Schinz, *privatdocent* at the University of Zürich. It is entitled "Conspectus Floræ Africæ," and will be published (by subscription) in six volumes.

THE Botanical Society of Edinburgh prints, in the latest instalment of its Transactions and Proceedings, a capital "preliminary notice" of the Pilcomayo Expedition, by Mr. J. Graham Kerr, naturalist to the Expedition. Mr. Kerr gives a short sketch of the Expedition itself, and then presents a summary of the more striking botanical features of the region traversed by it.

MESSRS. J. AND A. CHURCHILL have published the "Yearbook of Pharmacy," comprising abstracts of papers relating to pharmacy, materia medica, and chemistry, contributed to British and foreign journals from July 1, 1890, to June 30, 1891. The volume also contains the transactions of the British Pharmaceutical Conference at the twenty-eighth annual meeting, held at Cardiff, August 1891.

MESSRS. DULAU AND CO. have issued a catalogue of geological works which they offer for sale. The works relate to crystallography, mineralogy, mining, petrography, boulders, caves, vulcanology, water, &c.

SEVERAL new compounds of carbonyl platinum chloride and bromide with ammonia derivatives are described by Dr. Foerster in the current number of the *Berichte*. An account of the interesting carbonyl platinum compounds was given in NATURE, vol. xliv. p. 530, on the occasion of the publication by Drs. Foerster and Mylius of the results of their investigation concerning them. They were first obtained in 1868 by Schutzenberger by heating spongy platinum first in a stream of chlorine and afterwards in a current of carbon monoxide. The most stable and best investigated of these substances is the compound $COPtCl_2$. It is a crystalline substance possessing a somewhat basic character. The crystals readily dissolve in concentrated hydrochloric acid, forming the hydrochloride $COPtCl_2.HCl$. Nevertheless, the substance appears capable of combining with ammonia or its derivatives, for Schutzenberger obtained a compound, to which he assigned the formula $COPtCl_2.2NH_3$, by passing ammonia gas through a solution of carbonyl platinum chloride in carbon tetrachloride. As this ammonia compound does not readily lend itself to accurate analysis, Dr. Foerster determined to prepare a compound with a base such as aniline or pyridine, which would probably form crystals more capable of thorough investigation. For this purpose he chose the base pyridine, $C_5H_5N$. He finds that carbonyl platinum chloride does not combine with two, but with one molecule of the base, to form the compound $COPtCl_2.C_5H_5N$. This result is all the more satisfactory, inasmuch as Zeise has shown that the compound ethylene platinum chloride, $C_2H_4PtCl_2$, forms an analogous compound with one molecule of ammonia of the composition $C_2H_4PtCl_2.NH_3$. The new compound with pyridine, $COPtCl_2.C_5H_5N$, is a crystalline substance possessing basic properties, combining with hydrochloric acid to form the hydrochloride, $COPtCl_2.C_5H_5N.HCl$. Another new compound is obtained from the hydrochloric acid solution by the addition of more pyridine dissolved in alcohol, crystallizing out upon allowing the solution to stand a short time. When recrystallized from alcohol, this second compound is obtained in fine greenish-yellow crystals. Its empirical composition is $COPtCl.C_5H_5N$, but its molecular composition is probably represented by the double formula—

$$\begin{matrix} COPtCl.C_5H_5N \\ | \\ COPtCl.C_5H_5N \end{matrix}.$$

Water instantly decomposes it. In a similar manner two analogous compounds containing bromine have been obtained. The first of these, $COPtBr_2.C_5H_5N$, crystallizes in yellow tabular or acicular prisms, melting at the temperature, very low for a platinum compound, of 78°. The second compound, $(COPtBr)_2(C_5H_5N)_2$, is distinguished by its difficult solubility, only chloroform dissolving it in sufficient quantity for the purpose of recrystallization.

IN addition to the above compounds with pyridine, an interesting compound with phenylhydrazine has been obtained, $COPtCl_2.C_6H_5N_2H_3$, in fine crystals. The hydrochloride of this compound, $COPtCl_2.C_6H_5N_2H_3.HCl$, has also been prepared; it forms remarkably beautiful orange-coloured crystals. Indeed, it appears highly probable that hydrazine itself, $N_2H_4$, would be found to combine with these carbonyl compounds of platinum in a manner similar to ammonia and its derivatives.

THE additions to the Zoological Society's Gardens during the past week include a Diana Monkey (*Cercopithecus diana* ♀) from West Africa, presented by Mrs. R. Godfrey; a Rough-eyed Cayman (*Alligator sclerops*) from South America, presented by Mr. Charles Taylor; four Mississippi Alligators (*Alligator mississippiensis*) from South Carolina, presented by Mr. W. S. Copleston; four Gouldian Grass Finches (*Poëphila gouldiæ*), two Crimson Finches (*Estrelda phaëton*) from Australia, purchased; four Beautiful Grass Finches (*Poëphila mirabilis*) from Australia, purchased.

## OUR ASTRONOMICAL COLUMN.

WOLF'S PERIODIC COMET.—The following ephemeris, due to Dr. Berberich, is from one contained in *Edinburgh Circular* No. 21 :—

| 1892. | | Right Ascension. h. | m. | s. | Declination. ° | ′ | ″ | Brightness, that at discovery being = 1. |
|---|---|---|---|---|---|---|---|---|
| Jan. | 6 | 4 | 15 | 15 | − 13 | 39 | 5 | 3·24 |
| ,, | 10 | | 16 | 22 | 13 | 9 | 8 | 2·93 |
| ,, | 14 | | 17 | 55 | 12 | 36 | 9 | 2·66 |
| ,, | 18 | | 19 | 52 | 12 | 1 | 4 | 2·41 |
| ,, | 22 | | 22 | 10 | 11 | 23 | 8 | 2·19 |
| ,, | 26 | | 24 | 50 | 10 | 44 | 7 | 1·99 |
| ,, | 30 | | 27 | 51 | 10 | 4 | 5 | 1·81 |
| Feb. | 3 | | 31 | 12 | 9 | 23 | 7 | 1·65 |
| ,, | 7 | | 34 | 48 | 8 | 42 | 6 | 1·51 |
| ,, | 11 | | 38 | 42 | 8 | 1 | 6 | 1·38 |
| ,, | 15 | | 42 | 50 | 7 | 20 | 9 | 1·26 |
| ,, | 19 | | 47 | 12 | 6 | 40 | 8 | 1·15 |
| ,, | 23 | | 51 | 46 | 6 | 1 | 5 | 1·06 |
| ,, | 27 | | 56 | 33 | 5 | 23 | 2 | 0·97 |
| March | 2 | 5 | 1 | 30 | 4 | 46 | 0 | 0·89 |
| ,, | 6 | | 6 | 37 | 4 | 10 | 1 | 0·82 |
| ,, | 10 | | 11 | 53 | 3 | 35 | 5 | 0·76 |
| ,, | 14 | | 17 | 17 | 3 | 2 | 4 | 0·70 |
| ,, | 18 | | 22 | 48 | 2 | 30 | 8 | 0·65 |
| ,, | 22 | | 28 | 26 | 2 | 0 | 9 | 0·60 |
| ,, | 26 | | 34 | 9 | 1 | 32 | 7 | 0·56 |
| ,, | 30 | | 39 | 58 | 1 | 6 | 0 | 0·52 |

The comet is now a comparatively faint object, but can be seen with instruments of moderate aperture. It is in Eridanus, and moving slowly towards Orion. It has the same declination as Rigel on February 9, and passes about 4° north of this star on March 7.

THE DIFFRACTION EFFECTS PRODUCED BY PLACING SCREENS IN FRONT OF OBJECT-GLASSES formed the subject of a communication by Prof. Pritchard to the Paris Academy on December 28. The paper deals with the effects produced by meshes of metallic wires on the photographic and visual images of stars in the focus of refractors (photographic and ordinary) and reflectors. Numerous screens have been used in the investigation, but only the results obtained with three, designated by A, B, and C, are described. A was an iron wire screen having very nearly square meshes about 0·9 mm. apart, B a bronze one with meshes having an area of about 0·225 square mm., and C one having circular holes about 2·3 mm. diameter in it. Photometric observations of the intensities of the visual images of a bright star with and without A gave the relation 1/3·636 which, expressed in units of stellar magnitude of the ordinary scale, corresponds to an absorption by the screen of 1·40 magnitude. The same screen placed in front of a photographic telescope reduced stars of the ninth to the eleventh magnitude. There was thus a variation of $\frac{3}{5}$ of a magnitude in the effect produced by the same screen on the visual and photographic images of the same star. B intercepted light equivalent to 2·4 magnitude in the case of the observing telescope, and 2·8 magnitude in the case of the photographic one. C gave the values 1·44 and 1·83 magnitudes respectively. In all cases, therefore, the absorption of light was greater for the photographic than for the visual image. This is most probably due to the different treatment of the lenses by the optician in correcting them for photographic or visual work. Using the same screens in connection with reflectors, the intensities of the visual and photographic images were found to be the same, and the quotient of the intensity without a screen into the intensity with a screen was very nearly equal to the square of the portion of the screen traversed by the light.

REFRACTIVE POWER OF COMETARY MATTER.—Mr. Barnard communicates a paper to the *Astronomische Nachrichten*, No. 3072, on observations made of the difference of declination of 21 Asterope and 22 Asterope at the passage of Wolf's comet, 1891 September 3, through the Pleiades. As the opportunity afforded a good test to determine the refractive power of cometary matter, he, together with Mr. Burnham, instituted a series of measures of the declination of these stars before, during, and after, the transit of the comet over Asterope. Mr. Burnham's observations were made with the filar micrometer of the 36-inch equatorial, while Mr. Barnard used that of the 12-inch. The results obtained by the former indicated a small change, so small indeed that Mr. Barnard with his instrument could not detect any variation, or at any rate any difference of reading that would not be masked in the errors of observation. Mr. Burnham's measures are shown in the form of a curve, a vertical line corresponding to the time of nearest approach of the nucleus to Asterope, while a horizontal one indicates the mean $\Delta\delta$. The dots representing the observations gradually increase their declination, and then more quickly decrease, rising again only when the comet has transited the star. The results are most interesting, and the following is a short extract from the table. The time of nearest approach of the star and the nucleus occurred at 2h. 8·7m. sidereal time.

*Difference of Declination between* 21 *Asterope and* 22 *Asterope.*

| Sidereal time. h. m. | Individual readings. ″ | Sidereal time. h. m. | Individual readings. ″ |
|---|---|---|---|
| 2 1·5 | 95·07 | 2 9·5 | 94·86 |
| 2·5 | 94·60 | 10·5 | 94·75 |
| 3·5 | 94·95 | 11·5 | 94·79 |
| 4·5 | 95·c6 | 12·5 | 94·98 |
| 5·5 | 95·15 | 14·5 | 94·07 ? |
| 6·5 | 94·88 | 15·5 | 94·87 |
| 7·5 | 94·77 | 16·5 | 95·17 |
| 8·5 | 94·64 | 17·5 | 95·12 |

HIMMEL UND ERDE.—The December number of this "monthly" contains an interesting article by Dr. W. Zenker on "The Heating of the Earth's Surface by the Sun." That on "The Great Ice Age," by Prof. Dr. Albrecht Penck, begun in the November number, is here completed.

"WASHINGTON OBSERVATIONS, 1886."—This volume, just issued, contains the results of all the observations made during the year 1886 at the United States Naval Observatory, under the superintendence of Commander A. D. Brown, U.S.N. Under the heading of "The Transit Circle" and "The Meridian Transit Instrument," are given descriptions of the instruments, catalogues of miscellaneous stars observed, constants used in reductions, adopted corrections, clock rates and corrections, positions and semi-diameters of sun, moon, and planets, and many other details. Under "Observations and Results" are tabulated all the results obtained by the use of the transit circle, meridian circle, the equatorials of 26 and 9·6 inch aperture, &c. The magnetic observations made during the years 1888 and 1889 at the same Observatory by Ensign J. A. Hoogewerff, U.S.N., under the superintendence of Captain F. V. McNair, U.S.N., are also given, including both tabular statements and fourteen large plates.

## MOLECULAR WEIGHT OF GADOLINIA.

IN *Bihang till K. Svenska Vet.-Akad. Handlingar*, Band 17, Afd. ii., No. 1, Prof. A. E. Nordenskiöld returns to a subject which will always have a peculiarly fascinating interest for chemists. In spite of the vast amount of time and labour which has been expended upon the investigation of the rare earths contained in such minerals as gadolinite and samarskite, the mystery involved in the peculiar nature and reciprocal relations of these bodies is still far from having been solved.

It was in 1794 that Gadolin first examined the mineral gadolinite. Since that time the exceedingly complex nature of the new earth which he discovered has been continually demonstrated. Every fresh investigation seemed to result in the announcement of the discovery of a new element. The task of separating these different earths, which are so closely allied in their chemical properties, was exceedingly difficult and tedious. Mosander was one of the first to make use of the process of fractional precipitation, which, combined with spectroscopic methods, has in the hands of such scientific men as Delafontaine, Marignac, Lecoq de Boisbaudran, and Crookes, led to such interesting results. The investigations of Crookes on these rare earths resulted in the famous lecture on the "Genesis of the Elements," delivered before the Royal Institution in 1887.

The mention of this remarkable lecture brings us to the subject of the present paper, for one of the arguments employed by Crookes was that we had proof of the existence in nature of a mixture of isomorphous bodies, always associated together, and presenting a molecular weight so constant that they almost constitute a single body. That statement was made by giving importance (an exaggerated importance according to Marignac's criticism) to an interesting observation made by Prof. Nordenskiöld, who had announced (*Comptes rendus*, ciii. (1886), 795) the fact that the crude mixture of yttria earths, as precipitated from different minerals, although really a compound body, has nevertheless always a constant molecular weight, whatever may be the mineral from which it is extracted. To this mixture of earths, which thus behaves like an element, Prof. Nordenskiöld gave the name gadolinia, or oxide of gadolinium. In a subsequent paper (*Öfversigt af Vetenskaps-Akademiens Förhandlingar*, 1887, No. 7) in answer to the criticisms of Marignac and Rammelsberg, he showed that although the molecular weights for the individual earths which make up gadolinia vary between 136 and 394, yet the molecular weight for the mixture as a whole, obtained from a number of different minerals from various localities, only varied from 258 to 271.

The work of which an account is given in the paper now before us was undertaken in order to discover whether the above slight differences were only dependent on variations in the experimental methods. The author has not attempted to make any separation of the individual earths, but has confined himself to further determinations of the molecular weight of the group as a whole. The result of fifty-four determinations made upon such minerals as gadolinite, orthite, samarskite, monazite, &c., from various localities was to show that gadolinia from widely different sources has a molecular weight ranging from 247·9 to 275·8. The gadolinia used in these determinations was obtained by first separating the cerium metals by precipitation with potassium sulphate, precipitating the filtrate with ammonia, dissolving this precipitate, and reprecipitating with oxalic acid. Care was taken to avoid any fractionation which might occur, but any fear on this account was discounted by the unexpected discovery made during the course of the work that any gadolinia fractioned out (*e.g.* thrown down with the cerium oxides in the $K_2SO_4$ precipitate) had a molecular weight differing only very slightly from that of the rest of the earth.

The criticism which the author next applies to eighty-one molecular weight determinations made by Blomstrand, Engström, Rammelsberg, and others, leads to the rejection of forty, either owing to the small amount or to the impurity of the material used. The numbers in the case of the forty-one determinations retained fall within the limits obtained by the author.

Now, the molecular weights of the twelve earths which are at present stated to enter into the composition of gadolinia range from that of scandia, 136, and yttria, 227, to that of ytterbia, 394; so that the fact that, in spite of this wide divergence in the molecular weights of the constituents, the molecular weight of gadolinia itself only varies by at most 5·4 per cent. from the mean value, 262, is sufficiently startling. Thus no gadolinia has yet been found containing exclusively one only of these individual earths. The author shows, by a review of other minerals containing isomorphous groups of elements, how distinct in this respect is the behaviour of this group of yttria earths.

We have seen what use Crookes has made of these curious facts. We will conclude, therefore, by giving Marignac's conclusions on the same subject, as contained in his criticism of the author's previous paper. He is of opinion that all that can be affirmed is that yttria is always met with in nature mixed with a variable number of analogous and isomorphous earths *of much higher molecular weight*, and that it is always the dominating element in this mixture.

G. T. P.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Physical Society,** December 18, 1891.—Prof. W. E. Ayrton, F.R.S., President, in the chair.—The President announced that it had been found necessary to alter the dates of the meetings to be held after Christmas from those already published to the following: January 22, February 12 and 26, March 11 and 25, April 8, May 13 and 27, June 10 and 24.—A note on interference with alternating currents was communicated by Mr. M. H. Kilgour. Whilst studying Dr. Fleming's paper on some effects of alternate current flow in circuits having capacity and self-induction, the author constructed some additional curves. He was thereby led to investigate whether the serious rises of pressure produced by adding capacity would occur over considerable ranges of capacity, or whether they would only take place when the capacity was nearly equal to a particular value. Taking the case of a condenser of capacity C farads, in series with a circuit of resistance R ohms, and inductance L henrys, he showed that the maximum value of λ (the ratio of the pressure across the condenser terminals to that across the condenser and inductive resistance) is obtained when

$$C = \frac{L}{R^2 + p^2L^2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where $p = 2\pi$ times the frequency. The maximum value of λ produced by this capacity being given by the expression

$$\Lambda = \frac{\sqrt{R^2 + p^2L^2}}{R}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Taking $R = 10$, and $p = 2\pi \cdot 1000$, curves plotted from equations (1) and (2) between C and L, and between Λ and L had been drawn. The CL curve rises to a very sharp peak at $L = 0·0015$, and falls rapidly. That between Λ and L starts horizontal and bends upwards, and approximates to an inclined straight line for values of L greater than 0·002; when $L = 0·1$, $\Lambda = 63$. Considering the question of the range of capacity with which a given rise of pressure can occur, it was pointed out that when the values of L, R, and $p$ are such as to make a large rise possible, a rise exceeding a moderate value can only be obtained for values of C differing little from that given by equation (1). On the other hand, when the circuit is such that the maximum rise possible is not large, then a rise exceeding a given moderate value can be obtained over a much wider range of capacity. Hence the author concludes that the larger the possible rise the smaller is the probability of a serious rise occurring. The effect of shunting the condenser by a circuit of resistance $r$ and inductance $l$ is next dealt with in the paper, and the values of C which make λ a maximum determined, as well as the maximum value L can have. Subsequently the author examines whether the practical case of an alternator feeding a transformer through a concentric cable may be simplified without introducing serious error by assuming the capacity concentrated at either end of the cable, and concludes that in ordinary cases little error will be thus made. In an experiment made with a 100 kilowatt alternator, $\frac{3}{4}$ mile of $\frac{37}{16}$ concentric cable, and an 18 kilowatt transformer, a rise of $\frac{1}{4}$ per cent. was found to occur at the terminals of the alternator when the cable was connected. Putting on the transformer unloaded or loaded with but a dozen 16 candle-power lamps produced little change in the rise of pressure, this in all cases being between 0·2 and 0·3 per cent. Dr. Sumpner asked whether the conclusions as to the range of capacity with which a given rise of pressure was possible, were true for small rises such as occur in practice. Cases where the maximum possible rise was of the order 63 were not likely to occur at ordinary frequencies. The highest rise he had ever known was 11. He thought the time-constant of the inductive coil chosen—viz. $\frac{1}{100}$ of a second—was very large. In circuits containing iron it was practically impossible to get such large time-constants, for the power spent in the iron increased the effective resistance. Referring to the narrow range of capacity within which large rises were possible, he pointed out that such cases were found in Hertz's resonators, where the rises were immense, but to obtain them the adjustments had to be very accurately made. Dr. S. P. Thompson said he regretted that Prof. Fleming was not present, for he had recently investigated Hertz's experiments, and had obtained curves very similar to those got for the Deptford mains. The curve between Λ and L was very interesting. It was, in fact, a curve between the secant of the angle of lag and L, as could be seen from formula (2). In practice one would be working on the lower portion, and hence the rises would be small. Mr. Kilgour explained that in the paper his first object was to show that the product of the ange of capacity between which a rise greater than a given value would occur and the maximum possible rise was approximately constant for different circuits. Secondly, he wished to prove that the capacity of concentric cables could be assumed to be localized at either end without introducing much error in the rises of pressure calculated therefrom. Dr. Thompson, speaking of nomenclature, regretted that the word inductance should be used sometimes for L and at other times for $Lp$, and thought its meaning should be restricted to the latter. Prof. Perry said a name was needed for coefficient of self-induction. Resistance was practically independent of frequency, and "inductance" should have no reference to frequency. Dr. Sumpner thought it important to have a name for $Lp$, for that quantity comes into calculations most frequently. He would have preferred that "inductance" should mean $Lp$, but Mr. O. Heaviside, who introduced the term, had used it for L. The President remarked that some time ago Dr. Sumpner and himself felt the need of a name for $Lp$, and thought of using "inductance," but on referring to Mr. Heaviside's articles found it used for L. Dr. C. V. Burton asked whether the word "self-induction" could not be used as an abbreviation for "coefficient of self-induction." Dr. Thompson pointed out that this word already had a meaning, viz. L multiplied by current. Dr. Burton then suggested that inductivity might be applicable. Dr. Thompson said the word "impedance" was also used ambiguously, for the sense in which Dr. Lodge uses it in his "Modern Views of Electricity" is not the same as the vector sum of R and $Lp$. Prof. Perry recalled the fact that "impedance" had been defined by the Committee of the British Association as the ratio $\frac{\text{effective voltage}}{\text{effective current}}$. Dr. Thompson said this definition was only applicable to periodic currents, and not to intermittent or transient ones. The President said he understood the first object of Mr. Kilgour's paper was to inquire whether the dread of rise of voltage occurring when concentric mains were used need exist. When Dr Fleming's paper was read, the general idea was that concentric cables were dangerous. In the discussion on it, he, amongst others, had pointed out that the chance of a large rise of pressure was not a serious one. Mr. Kilgour had now shown that the range of capacity over which a particular rise could occur is inversely proportional to the maximum rise possible in the particular circuit. When the circuit was such that a large rise was possible, the probability of any serious rise taking place was very small, hence the fears of large rises were more or less unfounded. The second part of the paper was to show that ordinary problems on concentric cables could, in practice, be treated with sufficient accuracy by assuming the capacity localized at either end of the cable, instead of distributed along its length.

**Royal Microscopical Society**, December 16, 1891.—Dr. R. Braithwaite, President, in the chair.—Mr. E. M. Nelson said he had severely tested Messrs. Powell and Lealand's new apochromatic $\frac{1}{12}$ of 1·4 N.A. both visually and photographically, and he could say it was of remarkably fine glass. It gave an image more free of colour than that of many apochromatics he had seen; its speed in microphotography was very great. He noted it was fitted with a correction collar.—Mr. H. Bernard exhibited and described a new form of mechanical stage which he had invented; it was specially designed to obviate the inconvenience arising on account of the very limited range of motion admitted by those at present in use. The plan which he had tried to follow was to imitate the movement of the fingers as they are used for moving glass slides under the microscope. The mechanism was all under and at the side of the stage. Slides were moved by light adjustable frames. In this way a movement of 10 cm. by 5 cm. was speedily obtained without jarring against the condenser, or interfering with the light. Large slips with series of sections could thus be very easily examined, and zoophyte troughs could be searched from corner to corner. By placing a brass plate on the movable frame it was shown that the contents of a watch-glass could be closely examined, the movement avoiding the usual shaking of the fluid caused when watch-glasses are manipulated by the fingers. He had shown the original drawings of the stage to Prof. Abbe, who thought the idea was so good that he had had the stage exhibited made by the firm of Zeiss. The President, in thanking Mr. Bernard for bringing this stage to their notice, expressed the opinion that it was likely to be found most useful for dissecting purposes. He had often felt the inconvenience arising from the want of a greater range of movement in the ordinary mechanical stage. After the business of the meeting was over, Mr. Bernard gave a demonstration to the Fellows, and very favourable comments were passed on its practical use and originality.—Prof. J. W. Groves read a letter from Mr. Hermann giving information that *Volvox globator* was to be found in great abundance in a pond in the neighbourhood of Balham.—A paper on the resolution of *Podura*, by the Hon. J. G. P. Vereker, was read by Prof. Groves. The author stated that he had been experimenting in photomicrography on some scales of *Podura*, and had obtained results which he thought threw some light upon their structure. The photomicrographs exhibited he considered appeared to prove that the *Podura* scale consists of a hyaline beaded membrane, having minute featherlets inserted in it. At the broadest part of the scale there are one or two rows of beads between the featherlets, while towards the base and top of the scale the beads tend to form single rows. Mr. E. M. Nelson believed that the effects were due to the thickening of the membrane. Mr. J. E. Ingpen said that Mr. Wenham had gone into this subject, and he had come to the conclusion that the markings were inflations of the membrane.—The President reminded the Fellows that the next meeting would be the anniversary, and that it would therefore be necessary to appoint two auditors to examine the treasurer's accounts; on behalf of the Council he had appointed Mr. W. T. Suffolk. Mr. Nelson proposed, and Mr. Wynne E. Baxter seconded, Mr. J. M. Allen as auditor on the part of the Fellows. This was put to the meeting and unanimously carried.

### EDINBURGH.

**Royal Society**, December 21, 1891.—Dr. William Craig in the chair.—Prof. Crum Brown communicated an obituary notice of the late Mr. Andrew Young, by the Rev. Prof. Flint.—Prof. Crum Brown also read a preliminary communication, by Dr. Dawson Turner, on the electric resistance of various urines. The electric resistance is found to vary markedly when the proportion of solid constituents in solution is different. This test promises to be of use to the medical practitioner. Kohlrausch's method of determining the resistance by alternating currents and the telephone was adopted.—Mr. Malcolm Laurie read a paper on some Eurypterid remains from the Upper Silurian deposits of the Pentland Hills. This collection of fossils is now in the Edinburgh Museum of Science and Art, and contains a number of new forms, one of which has been the type of a new genus—*Drepanopterus.* This form is characterized by great breadth of carapace, and by the form of the single limb which is preserved. The limb is long and narrow, and ends in a slightly expanded sickle-shaped segment. The genus appears to occupy a position intermediate between *Eurypterus* and *Stylonurus*. Among the other remains are found two new species of *Stylonurus*—*S. ornatus* and *S. macrophthalmus.* Two new species of *Eurypterus* are also represented—*E. conicus* and *E. cyclophthalmus*. The second species of Stylonurus and both species of Eurypterus are characterized by exceptionally large eyes.—Prof. Cossar Ewart read the second part of a paper, written by himself and Mr. J. C. Mitchell, on the lateral sense-organs of Elasmobranchs. In this part the authors dealt with the sensory canals in *Raia batis*. It has been supposed that these canals serve for the production of mucus. The authors consider that this idea must be abandoned. They have observed a number of mucus glands in the skin sufficient to account for all the mucus found on the surface. They incline to the opinion that the canals have some respiratory function.

### PARIS.

**Academy of Sciences**, December 28, 1891.—M. Duchartre in the chair.—On a telescope *reseau*, by M. Mascart.—Note, by M. Faye, accompanying the presentation of the *Annuaire du Bureau des Longitudes* for 1892.—On the number of roots common to several simultaneous equations, by M. Kronecker.—Another note on the same subject, by M. mile Picard.—On the glycolytic and saccharifying powers of the blood in hyperglycemic asphyxia, in phloridzic diabetes, and in the diabetes of man, and on the localization of the saccharifying ferment in the blood, by MM. R. Lépine and Barral.—Note on the diffraction effects produced by screens placed in front of photographic and ordinary object-glasses, by Prof. Pritchard. (See Our Astronomical Column.)—On conjugate systems with equal invariants, by M. G. Kœnigs.—On the theory of linear differential equations, by M. André Markoff.—Complement to one of Abel's problems, by M. Bougaieff.—On a new spectrometer (*réfractomètre*), by M. C. Féry. The principle upon which the instrument has been constructed consists in annulling, by a solid prism of variable angle and constant index of refraction, the deviation produced by a hollow prism having a constant small angle, and filled with the liquid whose refractive index is required. To realize these conditions, a prismatic-shaped cavity has been cut out of a double-convex lens in a plane perpendicular to the axis. This cavity is filled with the liquid under examination. And since, in a lens, the angle formed by the plane tangents to the surfaces of curvature is sensibly proportional to the distance from the optical centre, the angle of the lens considered as a prism can be varied by motion in a plane perpendicular to the axis. The amount of lateral motion necessary to bring about no deviation, when the lens containing a liquid is placed between a collimator and an observing telescope, furnishes the datum from which the index of refraction of the liquid can be calculated. The determinations that have been made indicate that the method is susceptible of high accuracy.—Researches on the application of measurements of rotatory power to the determination of combinations formed by sorbite in aqueous solution with acid sodium and ammonium molybdates, by M. D. Gernez.—Metallic borates, by M. H. Le Chatelier. The author has prepared, purified, and analyzed borates of magnesium, calcium, and zinc. He concludes that many of the complex borates previously described are in reality mixtures of comparatively simple borates with boric anhydride, and that the only types of borates of which the composition is sufficiently established are: $B_2O_3$, 3MO; $B_2O_3$, 2MO; $B_2O_3$, 1·5MO; and $B_2O_3$, MO.—On isomeric chromic sulphates, by M. A. Recoura.—On a silicon chlorosulphide, by M. A. Besson. The compound $Si_2Cl_2S_2$ has been obtained as a white solid, crystallizing in long needles melting at 74°, readily decomposing in the air, and acted on with violence by water.—A new crystallized copper phosphide, by M. Granger.—The solution of antimony chloride in saturated solutions of sodium chloride, by M. H. Causse.—On a double cyanide of copper and ammonium, by M. E. Fleurent.—Study of the thermal properties of bibasic organic acids: influence of the alcoholic function, by M. G. Massol.—Disodium glycol, by M. de Forcrand.—Action of dilute nitric acid on nononaphthene, by M. Konovaloff.—The formation of acetylene from bromoform, by M. P. Cazeneuve.—Action of phosphorus pentachloride on methylnaphthyl ketones: $\alpha$ and $\beta$ naphthylacetylenes, by M. J. A. Leroy.—Observations on the subject of a note of MM. Arm. Gautier and R. Drouin, by MM. Th. Schlœsing, *fils*, and Em. Laurent.—On the formation of cordierite in the sedimentary rocks fused by the coal fires at Commentry (Allier), by M. A. Lacroix. An examination of some rock specimens from Commentry, where the underground combustion of coal has been going on for some time, shows that the most abundant mineral constituting the lavas formed (especially tbe ropy varieties) is cordierite. This mineral occurs in small crystals, which have not, however, been isolated and analyzed. It is accompanied by octahedric spinellids in connection with anorthite, and small, almost rectangular, microlites. The augite often exhibits the chrondritic structure of meteorites. The variation in the relative abundance of cordierite, anorthite, and augite, their very unequal dimensions in different specimens, and the relative abundance or rarity of the glass, give rise to numerous interesting petrographical varieties. Mallard's rhabdite has been easily recognized. The facts show that cordierite is easily formed by the action of heat on sedimentary rocks; indeed, it appears from the observations to be an habitual product of Carboniferous rocks modified by heat.—Functions of the pectiniform organ of scorpions, by MM. Charles Brongniart and Gaubert.—On the *régime* of the oceanic sardine in 1890, by M. Georges Pouchet.—On the presence of *Heterodera Schachtii* in cultures of carnations at Nice, by M. Joannes Chatin.—On a phtiriasis of fibrous copper, caused, in an infant of five months, by *Phtirius inguinalis*, by M. Trouessart.—Observations on the cellulosic membrane, by M. L. Mangin.—On the penetration of the violet filaments of the Rhizoctone fungus in the roots of beetroot and lucern-grass, by M. Ed. Prillieux.—On the assimilation of parasitic plants by chlorophyll, by M. Gaston Bonnier.—Earthquake of October 28, 1891, in Central Japan, by M. Wada.

BERLIN.

**Physiological Society**, December 11, 1891.—Prof. du Bois Reymond, President, in the chair.—Prof. Fritsch gave an account, illustrated by specimens and preparations, of the general result of his investigations on feebly electrical fishes, as far as these dealt with the structural arrangement of the electric organ, the nerves to the same, and the nerve centres.—Dr. C. Benda spoke about his recent researches on spermatogenesis, entering fully into the part played by the archoplasm in the development of spermatozoa.

**Physical Society**, December 18, 1891.—Prof. Kundt, President, in the chair.—Prof. Schwalbe recalled to the Society the loss it had sustained in the death of Dr. Ewald, one of its earliest and formerly most active members.—Dr. Budde gave a *résumé* of the work which has been done during the last ten years on supersaturated solutions, and an account of the present state of the question.—Dr. Paschen spoke on gravitational attraction and its measurement by Cavendish and his successors, dealing specially with the work of Boys, whose methods he explained and whose apparatus he exhibited to the Society.

AMSTERDAM.

**Royal Academy of Sciences**, December 19, 1891.—Prof. van de Sande Bakhuyzen in the chair.—Dr. Bakhuis Roozeboom treated of the influence of isomorphism on the behaviour of double salts during solution. He studied the isotherm of 15° for the saturated solutions possible with the system $FeCl_3$, $NH_4Cl$, and $H_2O$. When representing the numbers of mol. $FeCl_3$ and $NH_4Cl$ pro 100 mol. $H_2O$ in the solution, this isotherm consists of three branches. The first gives the solutions in equilibrum with solid $FeCl_3.6H_2O$, the second with the double salt $FeCl_3.2NH_4Cl.H_2O$, the third with mixed crystals containing from ± 8 per cent. $FeCl_3$ to zero. The three branches have two points of sharp intersection. In the first coexist the double salt with $FeCl_3.6H_2O$, in the second the double salt with mixed crystals containing the highest possible percentage of $FeCl_3$. These results confirm the rule that with systems of three bodies the composition of a solution is variable when only one solid phase lies at the bottom, but determined when there are two solid phases. The occurrence of mixed crystals besides double salts modifies the behaviour of the solution when one or other of the composing salts is added continuously.—Mr. J. A. C. Oudemans spoke on levels. He had had to try two levels of an altazimuth of the Sumatra triangulation, having each an air chamber at one of their ends; using a bubble not longer than one-third of the scale, he found the value of a division in the first and last third two or three times larger than in the middle, so that he inclined to reject the levels. But trying the same levels with long bubbles—for instance, of two-thirds of the scale—they proved much better, the inclination given by the level-trier being nearly proportional to the indication of the level, and the remainder of the irregularity being easily taken into account by a table. The necessity of making up, by experiment, a table of the inclination in a function of the level-reading, being once admitted, the judgment about a level ought to depend, not so much on the uniformity of the curvature, as on the constancy (the bubble remaining of the same length) of the reading, the inclination being the same; which property may easily be tested by the level-trier.

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